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ENGINEERING AND MINING JOURNAL-PRESS

A CONSOLIDATION OF ENGINEERING AND MINING JOURNAL AND MINING AND SCIENTIFIC PRESS

In the Southeast Missouri lead district. Surface plant at No. 7 mine of the National Lead Co.'s St. Louis Smelting and Refining Works, at St. François. The shaft is 720 ft. in depth, the deepest in this section

Methods of Mining Copper in Arizona - II, by George J. Young — Studies in Slag Formation, by Herbert Lang — Mineralized Breccia Areas at Calico, California, by F. B. Weeks — Discussion: The Sinking Fund Formula — Situation at the Mines — New Machinery

New Cornelia Copper Co.
Ajo, Arizona
H. KENYON BURCH, *Cons. Eng.*

Equipment in the New Cornelia Concentrating Mill, at Ajo, Ariz., and Accessory Operations

Equipment	Trade Name or Type	Manufacturer and Address
Steam shovels	Osgood Model 105	Osgood Co., Marion, Ohio
Standard-gage ore cars	20-yd. automatic air side-dump cars.	
Pan conveyors		Case Crane & Engineering Co., Kilbourne & Jacobs Division, Columbus, Ohio
Gyratory crushers	McCully	Worthington Pump & Machinery Corporation, Cudahy, Wis.
	Gates Style K	Stephens Adamson Manufacturing Co., Aurora, Ill.
Motors and electrical equipment		Allis-Chalmers Manufacturing Co., Milwaukee
Conveyors	Ball-bearing	Westinghouse Electric & Manufacturing Co., Pittsburgh
		Stephens-Adamson Manufacturing Co., Aurora, Ill.
Rolls		Allis-Chalmers Manufacturing Co., Milwaukee
Ring grizzlies	Burch	Traylor Engineering & Manufacturing Co., Allentown, Pa.
Weightometers		Stephens-Adamson Manufacturing Co., Aurora, Ill.
Rod mills	Marcy	Herrick-Steele Manufacturing Co., Nashua, N. H.
Classifiers	Dorr	Queen City Foundry Co., Denver, Colo.
Tables	Plat-O	The Dorr Co., Denver, Colo.
Thickeners	Dorr	Deister Machine Co., Fort Wayne, Ind.
Vacuum filters	Drum	The Dorr Co., Denver, Colo.
Vacuum pumps		Oliver Continuous Filter Co., San Francisco, Calif.
Compressors		Ingersoll-Rand Co., El Paso, Tex.
Blowers	Turbo	Ingersoll-Rand Co., El Paso, Tex.
Magnetic clutches		De Laval Steam Turbine Co., Trenton, N. J.
Centrifugal pumps		Cutler-Hammer Manufacturing Co., Milwaukee
Wood stave pipe		De Laval Steam Turbine Co., Trenton, N. J.
Plunger pumps		Pacific Tank & Pipe Co., Los Angeles
Dayton couplings		Worthington Pump & Machinery Corporation, Cudahy, Wis.
V-notch meter		Youngstown Sheet & Tube Co., Youngstown, Ohio
Cranes	4,000 g.p.m. Yarway-Lea	Yarnall-Waring Co., Philadelphia
Conveyor belts		Pawling & Harnischfeger Co., Milwaukee
		Goodyear Tire & Rubber Co., Akron, Ohio
		Goodrich Rubber Co., Akron, Ohio
		New York Belting & Packing Co., New York
		Manhattan Rubber Manufacturing Co., Passaic, N. J.

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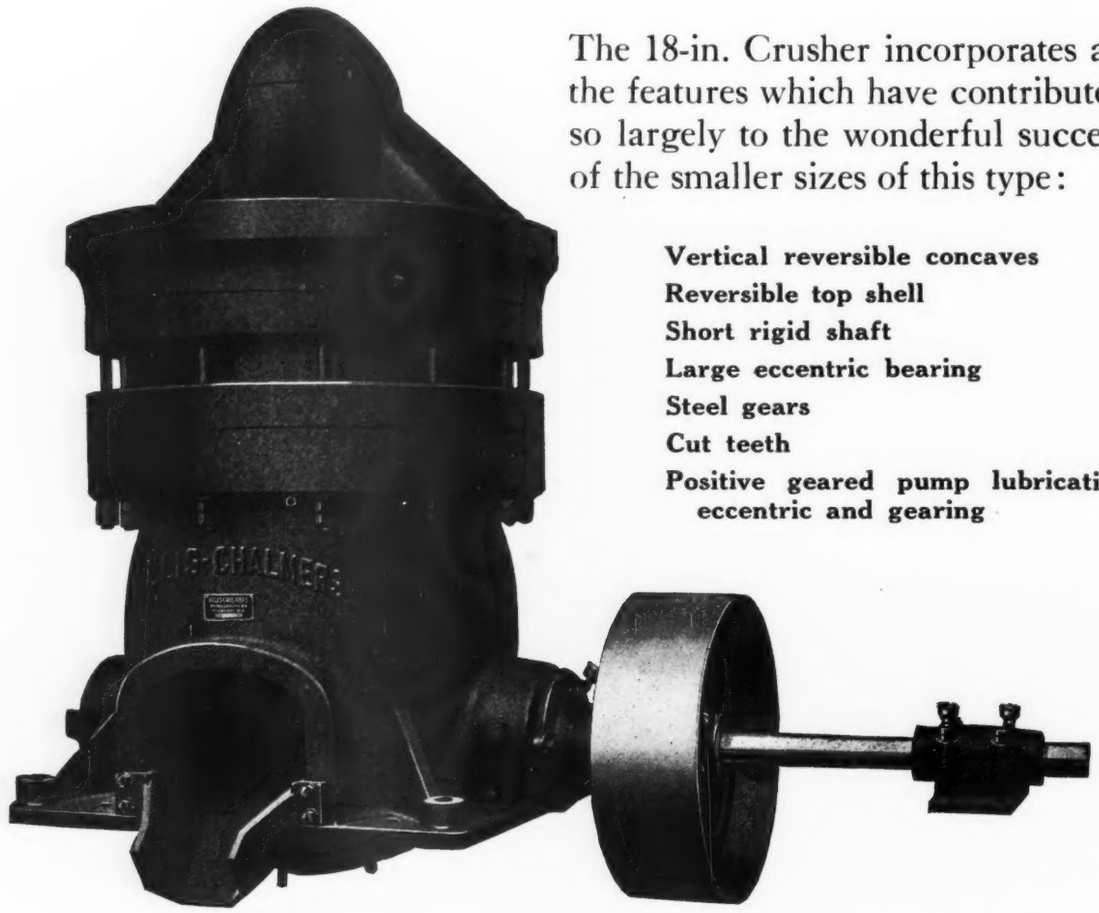
The latest development in the Superior McCully Fine Reduction line, furnished to a large Cement Company —having two feed openings, each 18 in. by 68 in.— capable of taking the product from the largest size primary crushers — capacity with minimum discharge opening of 2½ in.—225 to 275 tons per hour.



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ENGINEERING AND
MINING JOURNAL-PRESS

JOSIAH EDWARD SPURR, Editor

Volume 121 New York, March 20, 1926 *Number* 12

Delay in Government Publications

COMPLAINT on the part of the reading mining public concerning the slowness of issue of some of the government publications is perennial. The causes are various, and not well understood, while the apparent trouble and the resultant criticism is universal. Some of the troubles are due to excessive deliberation on the part of the government bureaus involved, to lax and easy-going methods of work and study on the part of the specialists making the investigation, to a lack of proper assistance to them, to hampering working conditions, to a lack of funds due to insufficient Congressional appropriations, to delay in the approval, by the various responsible authorities, of a finished report; and, finally, to the delays in the Government Printing Office. All these make for delay, and doubtless make for discouragement and a frequent indifference to promptness. Doubtless, also, the organization of a government bureau, with its men under Civil Service, and in no special danger of losing their jobs, whether they are prompt or dilatory, with a certain premium on inactivity provided it is accompanied by a certain front of assurance, tends to create an easy-going atmosphere lacking in the business world.

Some of the delays which result from this complex of conditions are inexcusable. An example of this is the revised Leadville Monograph, work on which (the Second Monograph) was begun by S. F. Emmons in the early 90's. The present editor of *Engineering and Mining Journal-Press* served as assistant to Mr. Emmons on this work in the summer of 1894. Since then work has been practically uninterrupted on this monograph, down to the present day; and every year for the last fifteen years at least its completion has been expected. What with the additional delay in the Government Printing Office at such time, if and when, the report is approved and turned over to it, there is some room for doubt as to whether it will ever appear. Certainly thirty-five years plus is too long a time to get out a geological report.

On the other hand, take the case of a government official who finishes a report promptly and endeavors to get it published as soon as possible. Suppose it is a report of 1925 containing figures of production, for example. The author has his report ready by the middle of June of this year, 1926. The process of reviewing consumes some time, so that it is transmitted for publication July 30. Editorial treatment within the Bureau and the preparation of illustrations takes, even with an order to give the report precedence, to Oct. 1, when it is finally approved for printing. The same urgent procedure in the Government Printing Office results in its taking only four months to print, so that it will appear about the first of February, 1927—bearing statistics, it will be noted, for 1925. This is a fair estimate of the minimum length of time required; some cases take longer, a few shorter. It is always the author, however, to whom criticism is directed.

The present editor of *Engineering and Mining Journal-Press*, when in the U. S. Geological Survey, completed a monograph on a mining camp within a year from the beginning of the field work, and had it ready for publication. Lack of funds kept the Director from sending it to the Government Printing Office, and the manuscript and maps lay in a drawer for two years, while the populace in the camp in question clamored for the report. Finally, at the author's urging, approval for publication was made; and careful checking up by the editorial department began. Something was found to be wrong about the scale of the numerous maps and sections. The author's investigations finally showed that the drafting paper supplied by the Survey, on which sections had been made, had shrunk decidedly in the two years—and more one way than the other—so much so that the sections had to be redrawn, at a cost of some hundreds of dollars and a marked delay. Finally, arrived at the Government Printing Office, the monograph lay there a long time, repeated preference being given to rush material asked for by Congress. By a personal visit and appeal by the author to the Government Printer, representing the difficulty of holding the populace in the camp in question at bay much longer, the work was finally taken up and was produced in a total of two years, making four in all. It was natural for the author to wonder why he had hurried, and if he shouldn't have taken his time, and filled out and polished his work.

Government efficiency bureaus may well be reminded of the admonition, "Physician, heal thyself"; and investigate how to avoid delay and waste in this manner.

The Latest Gold Boom

HAS ANOTHER MINING DISTRICT of importance been discovered on the North American continent, comparable to Goldfield, Cripple Creek, Klondike, Porcupine, Cobalt, and Kirkland Lake? Reference is not made here to the findings in the Rouyn district of Quebec, for that is now beginning to be an old story, but to the excitement way up in the northwestern corner of Ontario, at Red Lake, 130 miles from the National Transcontinental Railway at Hudson. The region was not virgin territory when the Howey claim was staked last fall. Outcrops of free gold had been found previously, a Hudson's Bay Co. post had been there for many years, and the district was explored by the Dowling expedition more than thirty years ago. Three years ago, a party was working further north, and in returning to the railway one of the old prospectors, Gus McManus, of Hearst, liked the looks of the ground around the south shore of Red Lake, which is composed of greenstones and old

sediments intruded by granite, granite porphyry, and quartz porphyry. He did not tarry at the time, but in a few days decided to go back; whereupon he made the discovery of gold. But it was not until last fall that the spectacular outcrops, with high assays over great widths, came to light. Snow soon covered the ground, and proof of what is there must wait till the coming summer, and a very short one it is, if any, in that latitude.

Lack of knowledge of what is there makes it all the more exciting. The Canadian papers are full of it, of course, and even the New York *World* has had several feature stories on the subject: tales of seven-day dog trips from Hudson to Red Lake; of forty men and their dogs huddled together in a small cabin on the way at night; of sugar at $1.25 a pound, butter at $2, even the lowly bean at 50c., and condensed milk running low. But a new feature adds to the spectacular nature of it all, a feature that was never thought of in the rush to the Klondike. On March 4 an airplane went into service, making the 130-mile trip in about an hour and forty minutes, instead of seven days, usually required, and with the temperature 30 below zero. A dollar a pound is charged for either freight or passengers. However, the plane is a Curtiss "jennie" and has little room left for freight after fuel for the round trip has been put aboard. So arrangements have just been made for one of the Lark type, which, by the time this is read, is expected to have been equipped with a special Wright engine, flown to Buffalo, equipped with runners for snow duty, and then flown for a thousand miles over a snow-covered waste to Red Lake. During the so-called summer season, Canadian flying boats will be in service.

Another cheer for the old Pre-Cambrian shield, and for the hardy pioneers that are invading it!

Beneficiating Ore in the Iron Country

FIGURES RECENTLY ISSUED by the Lake Superior Iron Ore Association put the grand total of iron ore shipped during 1925 from the Minnesota and Michigan ranges at 55,534,812 tons. From the Mesabi, of course, came the bulk of this tonnage, its mines sending to the furnaces almost 36,000,000 tons. The Gogebic range, Michigan's heaviest producer, was second, with a little over 7,000,000 tons. Following in order were the Menominee and Marquette ranges, with 5,269,633 and 4,197,846 tons respectively. The Cuyuna and the Vermilion ranges, in Minnesota, shipped about one and a half million each. The small balance remaining came from the Mayville and Baraboo ranges.

The extent to which the practice of beneficiating iron ore before shipment has grown is indicated by the fact that of the total tonnage recorded almost 16,000,000 tons was treated in one of several ways. About 6,177,000 tons was washed, 113,638 tons jigged, 123,209 tons treated by sintering and nodulizing, and 258,680 tons by drying. The treatment of the balance of over 9,000,000 tons consisted simply in crushing and screening before shipment. Screening, it should be explained, is employed for separating the ore from coarse pieces of taconite or rock, the separation being made on a basis of size alone. The process of washing consists in simply removing the sand, which is objected to at the furnaces. By drying, the moisture in the ore is reduced so as to improve the percentage of natural iron contained and to lessen the transportation charges. Any attempt to reduce the moisture below 8 to 10 per cent, however, is likely to make the ore dusty and difficult to handle. Drying is also sometimes accomplished by washing out the clay and ocher, which would otherwise retain considerable moisture. The only jigging plant in the iron country is that at the Mary Ellen mine, at Biwabik, on the Mesabi, an operation that is still in the experimental stage. Sintering is done at one plant —the Evergreen—on the Cuyuna. The ambitious nodulizing project at Babbitt marked time during the last year.

It is likely that each succeeding year will show a larger and larger tonnage of beneficiated ore produced. Thus ore not merchantable today will be made available for the market.

Heat-Treating Drill Steel Automatically

PROPER TEMPERING of drill steel has such an important effect on results in breaking ground that any effort to substitute the scientific precision of automatic control of this operation for the more or less accurate guesswork of the blacksmith's eye is worthy of attention. About one year ago the development of an automatic electrically operated heat-treating machine was announced by a company that was then newly entered in the business of making mining machinery. It was in April, 1922, however, that the first of these machines to be made was quietly installed in the shop of the New Jersey Zinc Co., where it has been in use ever since, to some extent as an experimental plant. Its service since then up to the present was described by C. M. Haight, mining engineer with the zinc company, at the recent New York meeting of the A.I.M.E.

For heating drills for sharpening, 1,900 deg. F. is allowed, according to Mr. Haight. At lower temperatures, the steels do not punch easily and are apt to get too cool for proper sharpening, thereby necessitating another heating. Drills thus treated have drilled as many as twenty-two holes (33 ft.) in limestone without resharpening. For hardening, the drills come out at about 1,450 deg. F. or about 150 deg. below the furnace temperature. Shanks are heated to about 1,600 deg. F. as judged by the blacksmith's eye. The machine is not used for hardening shanks, as the change from water to oil for quenching, and back again, would take too long.

About 112 drills per hour are handled by this machine at the maximum, the minimum being about 56. At Franklin 750 bits have been handled in eight hours without trouble, up to $1\frac{3}{4}$-in. gage. Two men are required to operate the machine, a runner and a helper. Output per man per shift is about 105 bits or shanks formed and heat-treated, this including making new drills, cutting old ones, straightening, and various other operations.

The uniform and correct results obtained from the use of the machine, says Mr. Haight, should considerably reduce the amount of steel to be sharpened and also lessen the transportation cost from the shop to the face and back again. At Franklin this is about 10c. Great opportunity exists for a machine of this sort. It is likely that the future will witness a widening use until it becomes standard practice—a course that the sharpener has pursued.

The Oil Conservation Board

UNDOUBTEDLY the Federal Oil Conservation Board appointed by the President a little over a year ago will be continued after June 30 next. A recommendation that the original appropriation of $50,000 be continued after the end of this fiscal year has been transmitted to Congress by the Bureau of the Budget. Though government inquiries of any sort are naturally disliked by petroleum operators generally, it is appreciated by all that the existing situation of wasteful overproduction needs a remedy. The attitude of the public was expressed by President Coolidge on appointing the four members of the board, when he said that the future of the oil industry might be left to the simple working of the law of supply and demand but for the patent fact that the industry's welfare was so intimately linked with the industrial prosperity and safety of the whole people. The operator's view was given by W. S. Farish, president of the American Petroleum Institute, at the opening of the recent public hearings before the board, when he said, "If the Nation's resources are being wasted in any way, if the national security and our future industrial prosperity are being jeopardized, then the nine billions of capital invested in petroleum industry is equally being wasted and placed in jeopardy."

A varying degree of enthusiasm for the board's inquiry may be read into Mr. Farish's remark by varying the emphasis on the word "if." Operators, the rest of the public, and the government undeniably have a mutuality of interest in the matter discussed, and the existence of the board should be continued until a clear understanding of the situation has been arrived at. As Mr. Farish further remarked, the facts of the oil situation will be more apparent at the end of the inquiry than they were at the beginning. Not only will an inventory have been taken of the country's petroleum resources, but the uses made of them will have been examined.

Three reports will be made by the board: on domestic conditions, on the foreign situation, and on possible substitutes for petroleum, respectively, the first of which will probably be ready before the present Congress adjourns. A complete record of the public hearings held in Washington a month ago has been issued.

Information Wanted

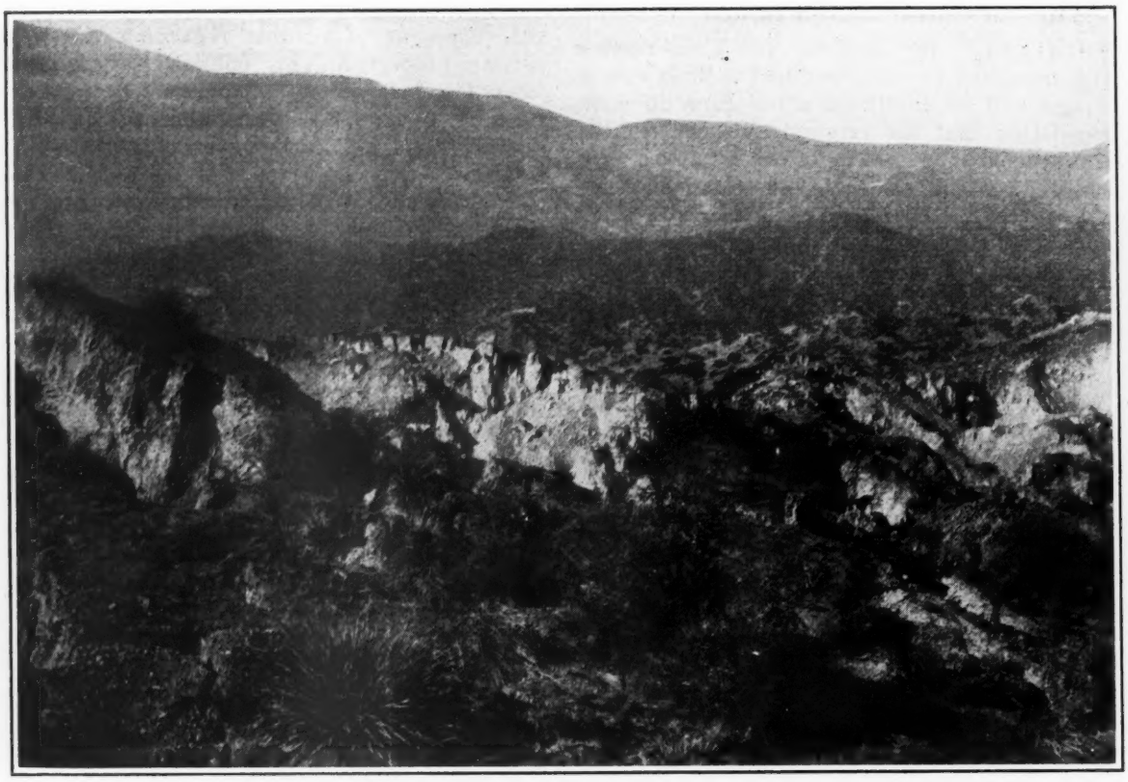
ENGLISH INVESTORS are naturally interested in the mining industries of the British Empire and of other countries, but apparently find it somewhat difficult to get accurate information about companies that are managed and operate far from home. They have had disagreeable experiences with some mining ventures, whereas others have been highly successful, and they are anxious to have some advice on which they can rely before risking their money. A London financial paper recently approached the Canadian Mining Institute with the suggestion that such advice might be given, but the Institute was without machinery to furnish it. *Engineering and Mining Journal-Press* also receives almost daily requests as to the standing of mining companies, or advice as to which mining stock offers the best speculation. No definite reply is possible in most instances, and yet the inquirer's honest desire for enlightenment is worthy of the greatest respect.

If one visits a mining district it is not difficult to get the consensus of opinion regarding the worth of a certain property. This opinion is exactly what the intending investor wants and which it is so difficult for him to get. Possibly state and provincial mining bureaus could well expand their activities in this direction, keeping a close record of the technical and financial condition of various companies coming within their jurisdiction, and being prepared to state the facts, and possibly an opinion that is not too committal. Such service would be of immense value and tend to offset the baneful influence of the usual broker's circular and Wall Street sucker publications.

Ore-Deposition or Ore-Injection?

WORDS are one of the chief stumbling blocks to forward thinking. The twin words vein and dike have proved an insuperable obstacle to the correct conception of igneous injection and magmas of igneous origin, on the part of the rank and file of geologists, since the dawn of modern geology. And it is not only geology that is thus handicapped, but clear thinking in general: words invented to serve as devices to ordered thought, and properly functioning as such, become deeply entrenched in the brain and become the lodging place for prejudices and inhibitions. Our simplest mental classification is that of the good and the not-good—as typified in God and the Devil; and words, meant to register complex ideas—ideograms—in the popular mind, evoke in the majority of cases only this simple reaction. *Radical,* for example; the usual reaction is simply—*not-good.* Socialist, not-good; Turk—not-good. Patriotism—good. Proletarian—not-so-good; labor-unionism — not-so-good; Nordic — good. Bromidioms, in short, furnish a string of catchwords whereby the average citizen may test his way blindly about the world, and pass for educated or semi-educated; and yet not overexert himself.

Old conceptions of the origin of metallic ores are swiftly changing. Not very long ago it was believed that ores were gradually built up by slow precipitation from waters—cold or hot—which, given the known immense duration of geologic time, were conceived to have mite by mite accomplished the relatively enormous result. These conceptions in a multitude of instances have been gradually disproved. The universal ore-precipitating work of meteoric waters, advocated not more than twenty-five or thirty years ago, is already in the museum; and many forms of successive postulates are by way of following into the same repository. In recent years, whenever the average ore deposit is carefully studied, it is found that ore precipitation is brief, and usually in successive clear-cut stages, which therefore are still briefer. Observation of ores closely allied with igneous rock intrusions, indeed, indicates in many or most cases a time factor in ore precipitation far more comparable to that of dike-introduction than to the original idea of ore-introduction. This being so, should we not abandon, with the old idea, a word which carries an inhibiting connotation, and drop "ore-deposition"—substituting words which fit more nearly the facts, such as "ore-injection," or at least "ore-introduction?" "Ore-deposition" may be reserved for sedimentary ores or for that great body of ore phenomena which are the work of meteoric waters in the shallow rock zones; but it would seem better to drop "ore-deposition" as applied to magmatic ores.



Subsidence of surface at Inspiration mine, Inspiration, Ariz.

Methods of Mining Copper in Arizona—II*

Details of Undercutting Practice at Inspiration, Ray, Miami and Morenci—Surface Subsidence Resulting from These Operations

By George J. Young
Associate Editor

AT ALL OF THE "PORPHYRY COPPERS," undercut caving methods are in use, but in each case practice has developed a distinctive method, which is, however, varied in accordance with the physical characteristics of the ground being worked.

Inspiration Undercutting Practice—At the Inspiration mine a well-worked-out method of undercutting has been developed and extensively used. In the ideal application of the method a mine haulage level is opened out on a plane 70 ft. beneath the lower ore intercept. Main haulage drifts are driven at 100-ft. intervals, and from these at intervals of 25 ft. incline raises are extended at angles of 50 deg. from both sides of the drift. At a point 35 to 40 ft. above the main haulageway a series of grizzly drifts, parallel with the main haulageways, is opened out. From these drifts at each grizzly incline raises are driven to a plane 15 ft. above, at which point a square set is put in above the top of the incline. The spacing of these square sets is at 25-ft. intervals in both directions. Each square set forms the starting point for short incline raises more or less curved to the undercutting level 15 ft. above. The finger raises are extended from the four sides of the square set. Chute controls are placed on the sides of the square sets. These consist of crossboards held by heavy cleats. Finger raises intersect the undercutting level at intervals of 12½ ft. in both directions. The undercutting level is thus characterized by more or less evenly spaced chute mouths distributed at the bottom of the ore plane. From the tops of the finger raises, undercutting drifts can be extended parallel with the grizzly drifts and at intervals of 25 ft. The arrangement is shown in Fig. 3 on page 478.

Undercutting practice varies, depending upon ground conditions. If the ground is good—that is, firm—the undercutting drifts are extended parallel with the grizzly drifts and at 25-ft. intervals. Undercutting starts at the corner of a block next to the solid ore on both sides. Shrinkage stopes are started from both directions at the corner of the block and serve as starting points. The inner angle formed by the meeting of the shrinkage stopes represents planes of weakness extending vertically upward. The line of retreat is away from the corner and toward the worked-out or caved sides of the block. Undercutting is effected in short stages by widening out the undercutting drifts at their ends, drilling fan-shaped rounds and blasting the series of rounds. The widened-out drift is supported by props where necessary. In blasting down, the timbers are blasted out first by using shorter fuses. The undercutting drifts are of small section, 5 by 6 ft., and are driven as they are needed. Generally the face

*Part I appeared last week. The article is concluded with this instalment.

Surface subsidence at Miami mine, Miami, Ariz.

is drawn back on an angle instead of straight across. The undercutting drifts can be extended at right angles to the haulageways, and this is done wherever it is more convenient to finish out a block in this way. Undercutting at the ends of the drifts varies in detail, depending upon local conditions. It may consist of a simple widening out and the drilling of the sides and top with rounds of holes, or one side of the drift may be drilled by flat holes and a short crosscut driven leaving a pillar on the side next to the cave. (Fig. 4.) The crosscut is drilled with fan-shaped rounds and the drift end blasted. Top holes are frequently omitted.

Another method of undercutting is to retreat from the caved side and end of a block toward the solid angle. Still another is to bell out the top above a finger raise and drill the top and sides of the small room thus formed. Access to the undercutting level is through the finger raises. The undercutting drifts are extended sufficiently to always give access to several finger raises beneath each series of undercutting rounds. Important advantages of the layout of the undercutting level are the opportunity of driving the undercutting drifts in either of two directions at right angles to each other, the variation in detail of undercutting, and the maintenance of a number of outlet points in any one section that is being undercut.

Drawing is under less control than in the case of Miami. The slope of broken ground is maintained at an angle of from 45 to 60 deg. Flat slopes are avoided, as they require too much advance development, but, on the other hand, too steep a slope develops a tendency for the waste to break through and get into the newly opened chutes. Chutes under a newly caved section are drawn fast at the start so as to initiate caving as soon as possible. It is the practice to draw sufficient ore to leave a void space above the undercutting level. This throws top weight upon the ore mass and breaks it down. As soon as caving starts, the rate of drawing is restricted, but is sufficient to keep the cave working but not so fast as to start caving in the portion of the block still to be undercut. Drawing is also influenced by the fact that, if the drawing rate is too slow, pressure develops sufficiently to pack the ore. The rate of drawing must therefore be sufficiently fast to ease the pressure developing in broken or caved ground. Wet or damp ore funnels through to the waste. Fine ore also tends to hole through. Coarse ore draws best.

For an ore mass 100 ft. in thickness, from four to six chutes are drawn at the haulage level. This distributes the loading. With twenty-car trains in use on the haulage level, every third car is beneath a chute. A maximum of from four to five cars are loaded at one time, but the usual number is two to three. This is an additional reason for drawing the ore to a slope. The active caved area is thus drawn from a length varying from 100 to 150 ft., depending somewhat upon the height of lift. Maximum height of lift is 300 ft. and is seldom less than 70 ft. The ore mass is worked in sections or panels.

Grizzly spacing is 10 in. Grizzlies consist of inverted rails 5 ft. long placed on 14-in. centers. Control gates are placed at the square sets. An arc type of gate is used at the chutes on the haulage level. Chute opening width is 30 in. Drawing records are obtained from the haulage level. The number of cars drawn from each chute is recorded, each trainman reporting for his train. Chute checkers apportion back the tonnage to individual fingers and direct the work of the chute tappers. As each chute raise draws from eight finger raises, it is evident that only a general approximation of the amount drawn from each can be made.

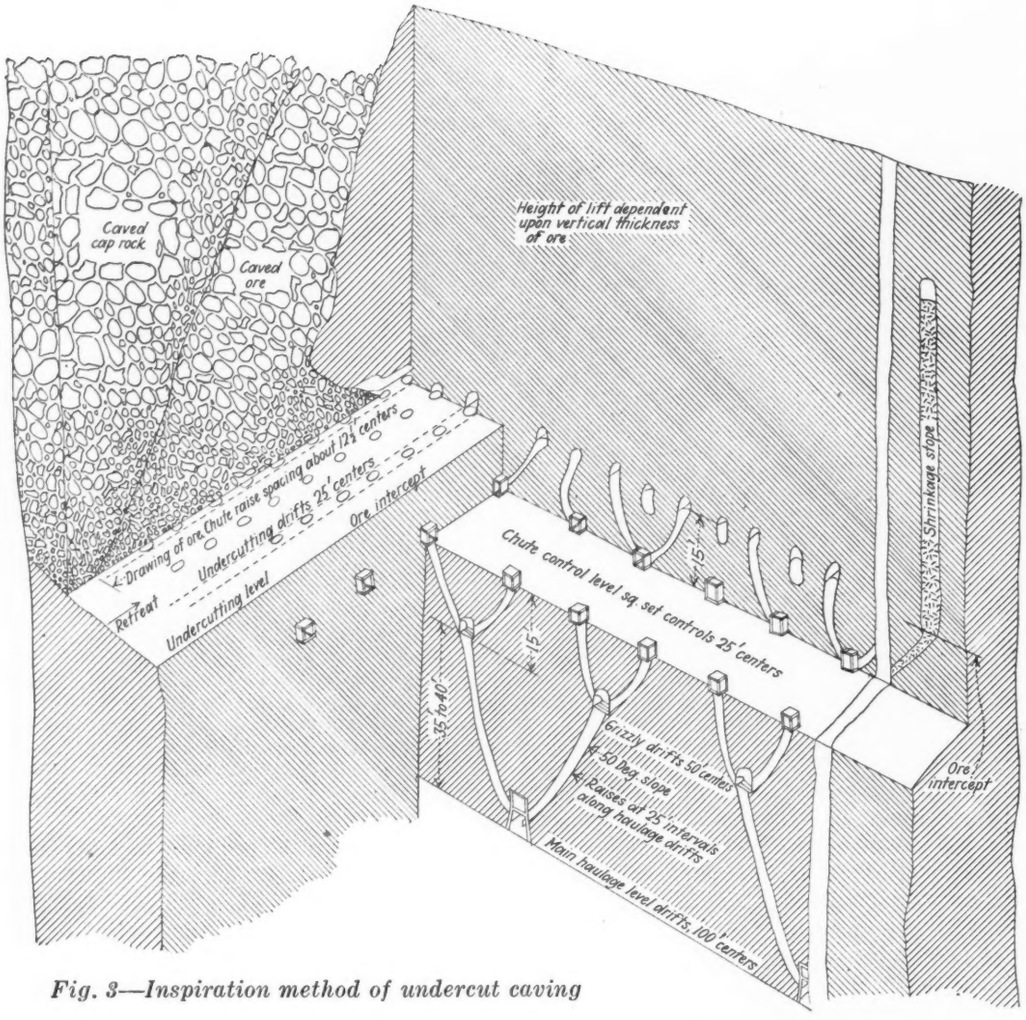


Fig. 3—Inspiration method of undercut caving

Haulageways are 9 ft. wide at the base, 7½ ft. wide at the top, and 7½ ft. high at the cap. A pony set is used at each raise intersection. Raises are 4 ft. in diameter and subdrifts are 6 by 7 ft. In soft ground the raises are cribbed solid and are 3 by 3 ft. or 3 by 4 ft. in the clear, the larger dimension being upright, as the bottom of the chute tends to build up if the ore is soft or moist. Compressed-air locomotives are used on the haulage level, handling trains of five-ton cars.

Output ratio is fifteen to seventeen tons per man-shift. It has gone as high as twenty tons, but is usually restricted to a lower figure, depending upon the amount of development in progress. Felix McDonald, who introduced the Ohio caving method, is principally responsible for the Inspiration undercutting method, which has the advantage of taking the entire height of ore below the cap rock in one lift, avoids hand tramming, and restricts the amount of active development work above the haulageways to that which is immediately productive or which comes into prompt production. Development work for an undercut area of 2,500 sq.ft. totals as follows: Main haulageway, 25 ft.; grizzly drifts, 50 ft.; incline raises, 240 ft.; undercutting drifts, 100 ft.; total 415 ft. The tonnage available for this undercut area is 20,000 tons for each 100 ft. height of lift above the undercutting level. Mucking in development work is restricted to an average horizontal movement of about 11 ft., as both the chute and grizzly raises are spaced 25 ft. centers. Mucking in the mining or undercutting drifts requires less horizontal transfer of the ore. There are no cones or hogbacks left.

Miami Undercutting Practice—The Miami orebodies are flat masses of irregular outline, generally lacking definite boundaries. One orebody, practically worked out, has a length of about 5,500 ft. and a maximum width of 1,600 ft. The ore mass consists of schist in certain sections and altered granite in others, and averages 2.26 per cent copper. Its hardness varies between wide extremes—ore that can be drilled with stoper at a rate of 34 in. per minute to ore that drills 3.5 in. per minute with a Waugh Turbro drill. The ore is friable, as is also the overburden, which is highly siliceous leached schist and altered granite porphyry.

Hensley states that the presence of water in the softer grades of ore, even in small quantities, increases its tendency to pack, not only in transfer raises but also in the caving operations. Drawing of the undercut ore is facilitated by opening up any section a month or so in advance of the time required for production, thus giving plenty of time for draining. Drying out of a section is helped by blowing large quantities of air through it before actual mining begins.

Undercutting practice in use at the Miami mine in 1925 was a retreating method across the face of a block 150 ft. in width. The sides of the block abutting against an ore intercept or against solid ore are cut off by narrow shrinkage stopes parallel with the direction of retreat. The lift taken at one time is 75 ft. measured above the tops of the drift timbers. Access to the tramming level of the block is obtained from a supply raise which connects with a main haulage level. The tramming level is developed by a series of parallel drifts at 25-ft. centers. These are connected with a fringe drift connecting with the raise. Crosscuts 4 by 6 ft. in section connect the tramming drifts at 100-ft. intervals. Tramming drifts are connected to the haulage level by raises driven at an angle of 53 deg. The horizontal interval between haulageways is 150 ft. and the vertical distance between haulage levels 150 ft.

Raises branch from both sides of the haulageways at intervals of 100 ft., which interval is sometimes reduced to 50 ft. in softer ground. Each raise branches into three short vertical raises connecting with as many tramming drifts. Thus, each haulageway serves six tramming drifts. Each series of raises serves 600 ft. of tramming drift and totals 400 ft., or $\frac{2}{3}$ ft. of raise for each foot of tramming drift and $\frac{1}{6}$ ft. of haulageway for each foot of tramming drift.

The upper of the two lifts above a haulage level is worked by tramming drifts parallel with the haulage level drifts. On the lower lift the tramming drifts are at right angles to the haulage drifts, and additional transfer raises are constructed so as to serve each tramming drift at 100-ft. intervals. The lower tramming level is placed about 35 ft. above the haulage level. There are thus two sets of transfer raises for each series of main haulage drifts.

From the tramming level, raises ("1" in Fig. 5) are put up at an angle of 50 deg. and at intervals of 50 ft. along each tramming drift, alternating right and left and connecting with short vertical raises reaching the undercutting level 25 ft. above the tramming level and on a line midway between two contiguous tramming drifts. Mining drifts are extended from the raises as they are needed. The mining drifts are parallel with the tramming drifts. Undercutting begins at the end of a mining drift and consists of enlarging the pilot drift to 8 by 8 ft. in cross section. ("2" in Fig. 5.) Fan-shaped rounds consisting of from nine to thirteen 8-ft. holes spaced from two to three feet apart are put in the roof and sides of the enlarged portion of the drift. The effect of these rounds is represented in "3" in Fig. 5. The ore is completely undercut at this level. After blasting down, part of the broken ore is drawn through the raises in advance of the regular drawing operations. This is done to give the back above the broken ore opportunity to break up and start caving. Undercutting on the mining level is from 50 to 75 ft. in advance of "working over timbers," which is the next step. In the meantime the tramming drift timbers have been placed and chute mouths constructed. At a point about 25 ft. back from the regular drawing chutes a short drift, 8 by 8 ft. in cross section, is driven

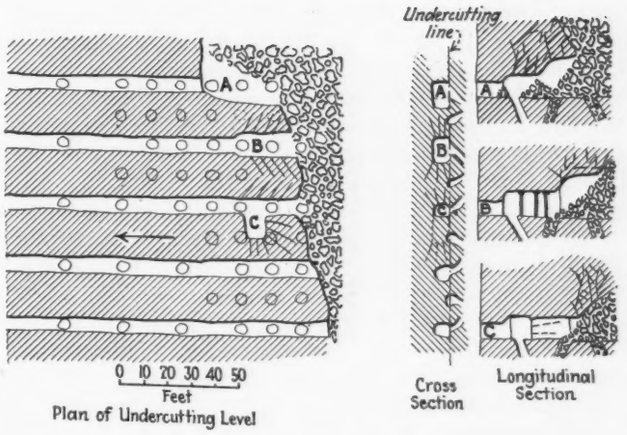


Fig. 4—Detail of undercutting practice at Inspiration

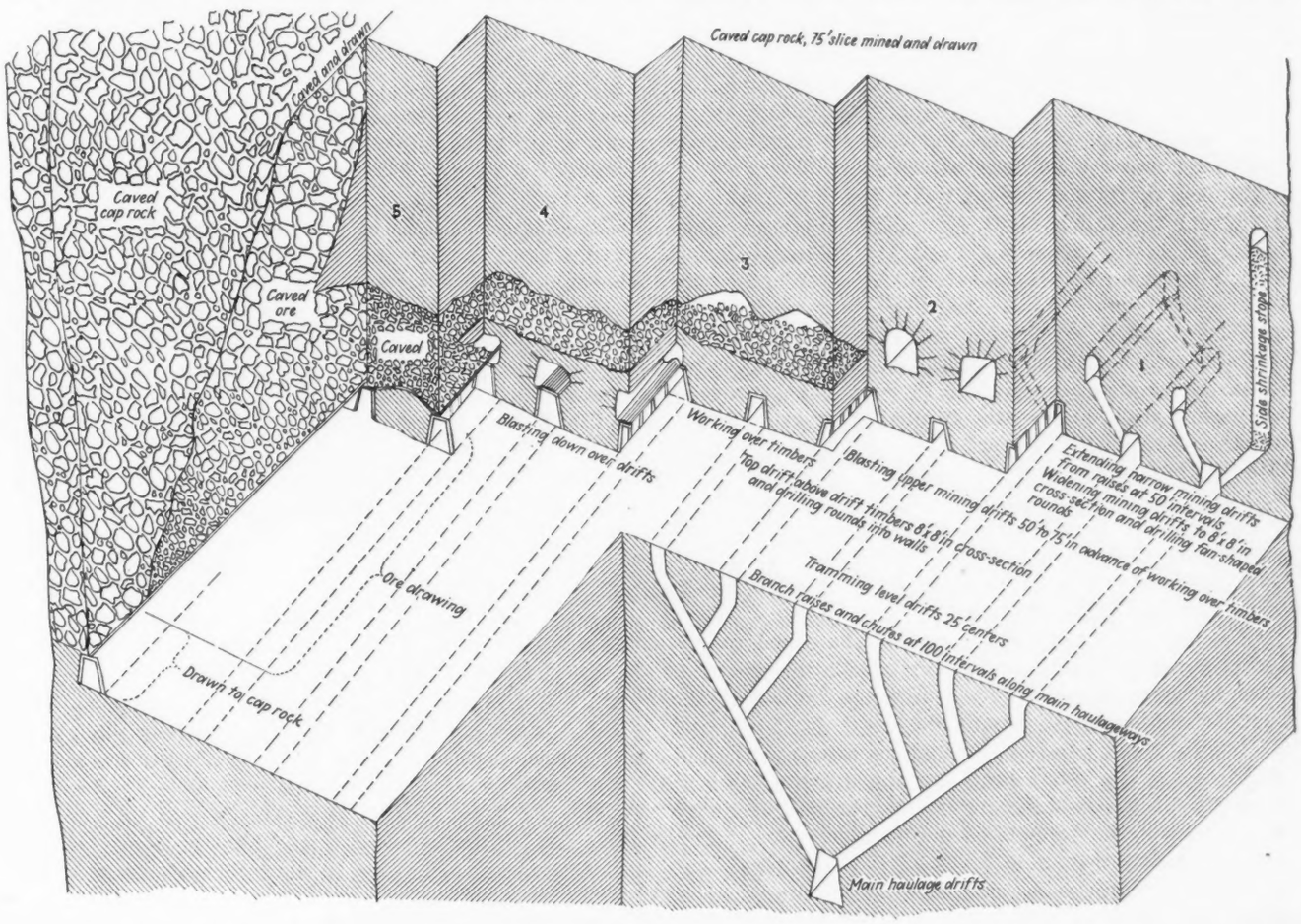

Caved cap rock, 75' slice mined and drawn
Caved and drawn
Caved cap rock
Caved ore
Caved
5
4
3
2
1
Slate shrinkage stope
Blasting down over drifts
Working over timbers
Top drift above drift timbers 8'x8' in cross-section and drilling rounds into walls
Blasting upper mining drifts 50' to 75' in advance of working over timbers
Extending narrow mining drifts from raises at 50' intervals. Widening mining drifts to 8'x8' in cross-section and drilling fan-shaped rounds
Ore drawing
Drawn to caved cap rock
Tramming level drifts 25' centers
Branch raises and chutes at 100' intervals along main haulageways
Main haulage drifts

Fig. 5—Miami method of undercut caving

over the tramming drift timbers ("4" in Fig. 5). Fan-shaped rounds of seven 7-ft. holes 3 ft. apart are placed in the roof and sides of the drift and blasted down. While the miners are working above timbers the two nearest chutes are sealed so that no ore can be drawn until the section above timbers has been blasted down. Fig. 5 illustrates the stages in undercutting. Timbering, consisting of props, is used both in the undercutting level and in working over timbers where necessary. The holes are drilled with stopers and pluggers, and mounted machines are sometimes used for flat holes. Crosscuts or connections are completely bulkheaded with old timbers when the drawing operations approach within 25 ft. of them. It is of interest to note that in the softer and weaker ore the first undercutting shown is omitted, and its use is now restricted to comparatively hard and strong ore.

The faces on both undercutting level and working over timbers are drawn back evenly across the width of the block, which may vary from 150 ft. to 200 ft. The drawing area ranges from 125 to 150 ft. along the tramming drifts. Chutes are spaced 6 ft. 3 in. center to center alternating on either side of the tramming drift, and are constructed of 2-in. plank with 2-in. board controls. The drift is timbered with 8-ft. posts and 6-ft. caps, both being of 12 by 12-in timber and set at 2 ft. 1 in. and 4 ft. 2 in. centers alternating along the course of the drift. The posts are set on a batter of 1½ in. per foot, and a 4-ft. spreader is used beneath the cap. Track gage is 18 in. and rails are 16 lb. to the yard. Main haulage tracks are 24-in. gage, 45-lb. steel; minimum radius of curvature 23 ft. and grade 0.5 per cent in favor of the load. End-dump cars, 16 and 20 cu.ft. sizes, with roller bearings, are used for hand tramming. Haulage level cars are gable bottom, roller bearing, 60 cu.ft. capacity. Motors are of the trolley type, six tons in weight. Supplies are hauled by four-ton storage-battery locomotives.

Haulage drifts are timbered with 10x10-in. posts, one 9 ft. and the other 9½ ft. (on ditch side) set on a batter of 1½ in. per foot. Caps are 10 by 10 in. by 8 ft., a spreader of 6 ft. 4 in. long being spiked on the lower side. Sets are spaced on 6 ft. 3 in. centers and are close lagged on the top and where necessary on the sides with 2 by 8-in. lagging. Incline transfers in harder ground are driven 5 by 5 ft. in section with temporary stulls and partition. In softer ground they are timbered with four-post sets, 6 by 8 in. and 6 by 6-in. timbers spaced on 4- to 5-ft. centers and lined with 2-in. plank, giving inside dimensions of 4 by 4 ft. A double layer of plank is used on the bottom of the inclined transfers where hard rock is to be handled. The second set of transfers consists of vertical raises 5 by 5 ft. inside dimensions.

In the softest and weakest ground the caved area is 100 ft. in width and 150 ft. long, the latter measurement being parallel with the tramming drifts. In the hardest and strongest ground the width is 150 ft. and the length 250 ft. In both ground conditions the height of lift is 75 ft. The length of the drawing area is governed by the rapidity of caving, the daily tonnage required, and the amount of maintenance work necessary upon the tramming level. Alternate panels are worked simultaneously, and the intervening panels after the caved overburden has settled. The time interval between starting alternate panels and starting the one in between approximates from nine to ten months. The distance between contiguous panels is about 200 ft., and this distance is maintained so that the relative positions of neighboring panels remains about the same. A panel 150 ft. wide and 75 ft. long contains 900 tons per foot of length, so that this 200-ft. interval represents 180,000 tons.

A single chute draws from a block 12½ ft. square and 75 ft. in height, representing 937 tons. The maximum rate of drawing is ninety tons per chute per day, indicating an apparent subsidence of 7.2 ft. per day. Drawing is so conducted that the angle between the broken ore and the caved cap rock is 45 deg. maximum. The average rate of subsidence in the better caving ground is 0.8 ft. per day. Drawing operations are in charge of efficiency engineers, who determine each day the amount to be drawn from certain chutes and outline the work for the three shifts. No more than this allowance is permitted to be drawn, and if waste appears the chute is sealed and allowed to pack, after which it is opened again. When the chutes on one side of a tramming drift show waste, the chute on the opposite side is drawn until it also shows waste. The amount drawn from each chute is recorded and totaled so that when the expectant tonnage has been reached the fact will be promptly known. Chute samples are taken at intervals and chutes are inspected by the efficiency engineers each day.

An example of the results of working an ore mass 500 by 500 by 325 ft. in height is given by J. H. Hensley, Jr. Expectant tonnage was 3,772,254 tons assaying 1.96 per cent copper. Extraction was 3,954,320 tons assaying 1.76 per cent copper, or tonnage extracted 104.8 per cent; grade extraction 90 per cent, and copper extraction 94.3 per cent. The ore mass was granite porphyry of a soft weak nature well adapted to caving. It was mined in three lifts varying from 50 to over 200 ft. in thickness.

Important features of the Miami method of undercutting and caving are the low height of lift, the thorough undercutting, and the close control over the drawing of the broken ore. The use of shrinkage stopes to limit the area to be caved by carrying them up 25 ft. or more at the boundaries is of interest, as is also the use of shrinkage stopes in hard ground to facilitate caving and prevent arching. The method is elastic in that the development plan is such that variations are possible and shrinkage stopes can be extended across the tramming drifts or parallel with their length. A new undercutting method is now being applied upon the low-grade orebody, but the details of this are not as yet available.

Part of the foregoing information was taken from a paper submitted by J. H. Hensley, Jr., to the Institute, but not yet published.

Ray Undercutting Practice—Present methods at Ray, Ariz., show the influence of the combined shrinkage and undercut-pillar method which was used for a long time and which has been described by Lester A. Blackner. Two general situations arise: in one the stopes are tributary to a main haulage level; in the other they are tributary to an intermediate or hand-tramming level.

On the hand-tramming levels, the drifts are spaced

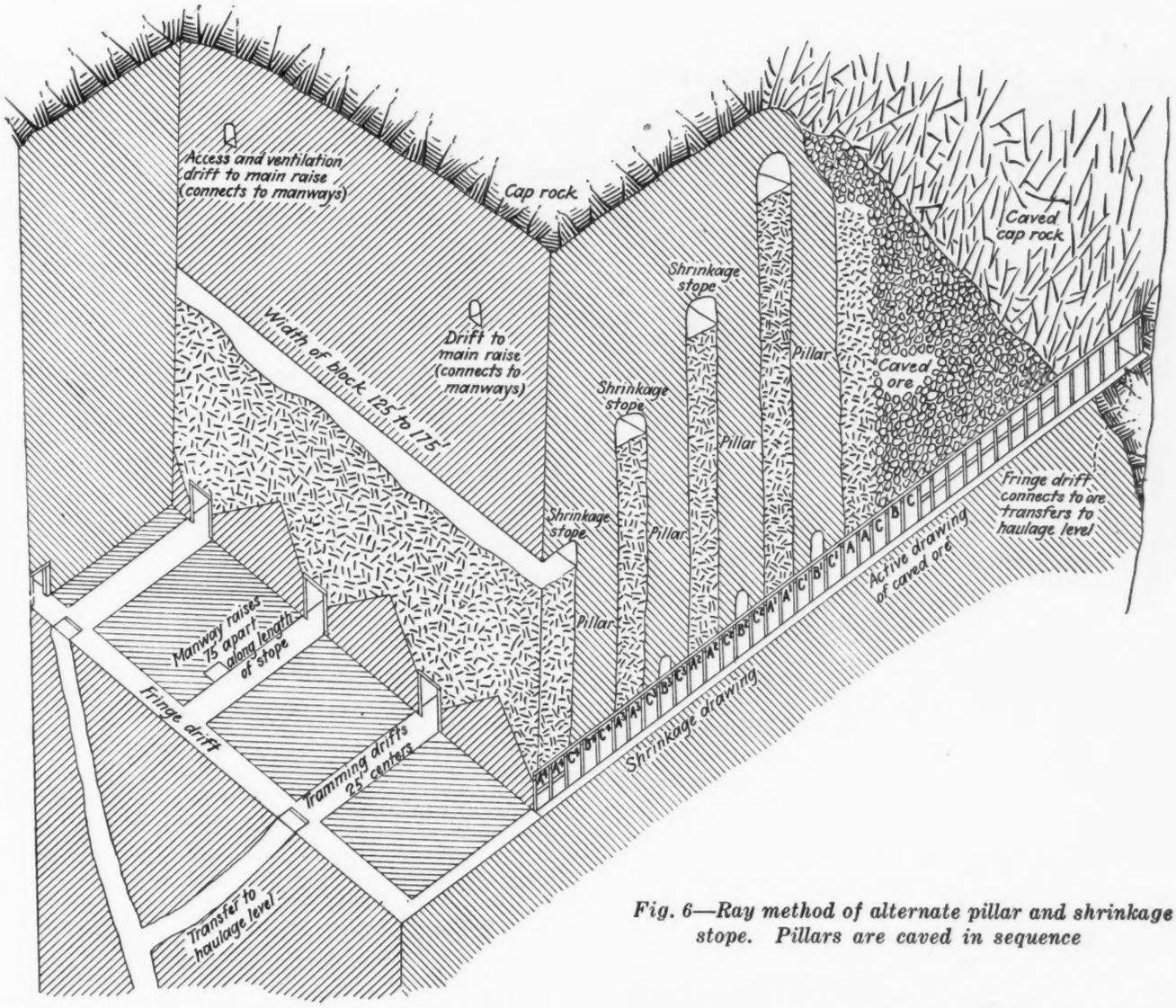


Fig. 6—Ray method of alternate pillar and shrinkage stope. Pillars are caved in sequence

at 25-ft. centers, and are timbered with rectangular sets and collar braces giving a clear width of 4 ft. 10 in., by 7 ft. 10 in., spaced at 5-ft. centers. Every space between the drift sets can be used for a chute mouth. Two distinct methods are used in mining hand-tram areas, depending on the nature of the ground. In hard ground, the original stope-and-pillar method is used, as shown in Fig. 6. Stope connections are carried across the block two sets in width, or 10 ft., as shown at *A*, *A*1, and *A*2. The actual width of the stope, however, as it is being carried up, depends entirely on the nature of the ground, and in good ground the stopes are carried at a width of 15 to 18 ft. Shrinkage stopes are carried up at 25-ft. intervals, leaving a pillar approximately 10 ft. wide between the stopes. Stopes are carried to the capping, and the final round is drilled fan-shape to cut off the tops of the pillars. Cribbed manways are carried up, with the stope, the number of these depending on the length of the stope, but they are spaced not more than 75 ft. apart. An open raise is usually carried in the middle of the stope, connecting with a small drift near the top of the ore. This raise provides ventilation for the stope and allows for the lowering of steel and supplies into the stope instead of hoisting them up the cribbed manways. As the stopes are completed, the pillars between the stopes are undercut by connecting raises across the block in the center of the pillars, as shown at *B*, *B*1, and *B*2, Fig. 6. After the pillars are undercut, chutes are built in the positions indicated in *C*, *C*1, and *C*2, and the ground in these chutes drilled and blasted. Chute mouths are thus provided at the shrinkage stope and the undercut pillar on both sides of the drift. Broken ore is drawn through these into cars and trammed to the end of the drifts, where it is dumped into transfers connecting with a main haulage level. The caved area is drawn across its full width and the rate of drawing is proportioned to maintain a steep slope between the caved cap rock and the broken ore. Successive pillars are undercut, retreating from one end of the block to the other. When the block is finished, the next block alongside is started in a similar manner.

The second method of undercutting requires the same layout of drifts, fringe drifts, and transfers. Fig. 7 illustrates this method. In this, shrinkage stopes are driven up to the cap rock and broken through to the cap rock, but no final round is shot. When the shrinkage stope nearest the caved overburden is finished, transverse raise connections are opened up at 15-ft. centers above the timbers in a single section.

Surface subsidence at Ray mine, Ray, Ariz.

Surface subsidence at Humboldt mine, Morenci, Ariz. The large size of the blocks is due to the greater hardness of the rock in the capping

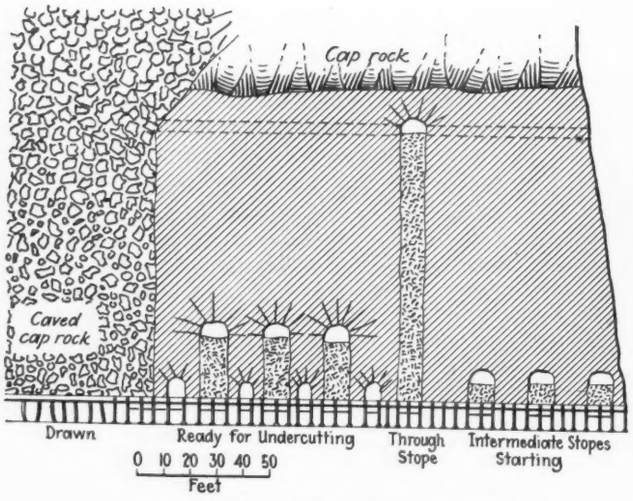


Fig. 8—Ray method of undercut-caving

This procedure results in less mixing of the broken ore and cap rock. The blocks are 125 ft. in height, or less.

These are drilled with fan-shaped rounds and blasted in sequence, beginning in the drift nearest the shrinkage stope. The ore cave is thus started at a point 50 to 75 ft. from the outer face of a block and carried back to this face. As in the other case, chute mouths are opened up on both sides of the drift and the drawing off is proportioned to maintain a sloping under surface on the caved cap rock. Successive sections are taken in retreat, but the undercutting of each block advances to the cave. This procedure results in less mixing of the broken ore and cap rock. The blocks are 125 ft. in height, or less.

In the motor levels, the laterals are driven at 40-ft. centers and the drifts are timbered with rectangular drift sets 7 ft. wide by 7 ft. 4 in. high, in the clear, and spaced at 5-ft. centers. On top of the drift sets, pony sets are placed, and draw-off chutes are built in the pony sets. In hard ground, the same procedure described in the discussion of the hand-tramming sections is followed.

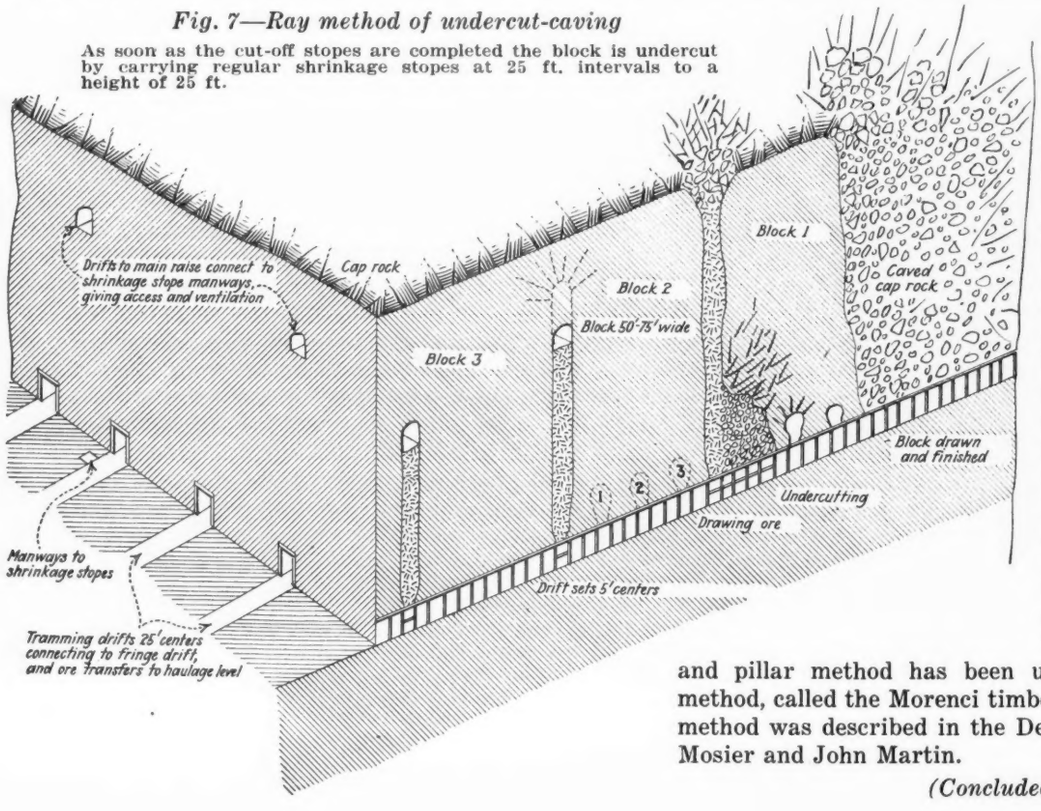
In the softer ground, which is adaptable to undercutting, the following method is used: Transverse stopes are carried up at 75-ft. intervals as in the hand-tramming areas and are extended up to the capping. A through stope is also carried up at the sides of the block, so that the block is entirely cut off. As soon as the cut-off stopes are completed, the block is undercut by carrying up regular shrinkage stopes at 25-ft. intervals to a height of 25 ft. (Fig. 8.) At this height they are drilled with a fan-shaped round. When these intermediate stopes are completed, the pillars are broken and the ore is drawn as described for the hand-tramming areas.

Motor drifts were driven at 50-ft. centers and later at 40-ft. centers, because of differences in the nature of the ground. In the upper parts of the mine the ore was hard and drew well over a large area. The talcy lower ore draws more steeply. Drifts on the lower blocks are offset with respect to the drifts immediately above. The talcy ore requires smaller blocks and more rapid drawing to prevent packing. The blocks are from 100 to 150 ft. wide. A motor section will produce 1,000 tons or more per day. No cone work is done in low-grade ore, the cones and hogbacks on one level being obtained by caving from the level below. In good-grade ore, these were mined from drawing drifts, driven down the center line of the cones. Output is about ten tons per man-shift. Stopers (*CC*-11) are used with 1¼-in. octagon drill steel. Wet machines are used in dusty stopes. Mounted drills use 1⅛ in. hollow round and pluggers ⅞-in. hollow hexagon steel. Bit changes are ⅛ in. Manways are 3 by 3 ft., in the clear, and are constructed of 3 by 6-in. by 4-ft. timber.

Acknowledgment is made to R. W. Thomas, mine superintendent at Ray, for the foregoing details.

Fig. 7—Ray method of undercut-caving

As soon as the cut-off stopes are completed the block is undercut by carrying regular shrinkage stopes at 25 ft. intervals to a height of 25 ft.



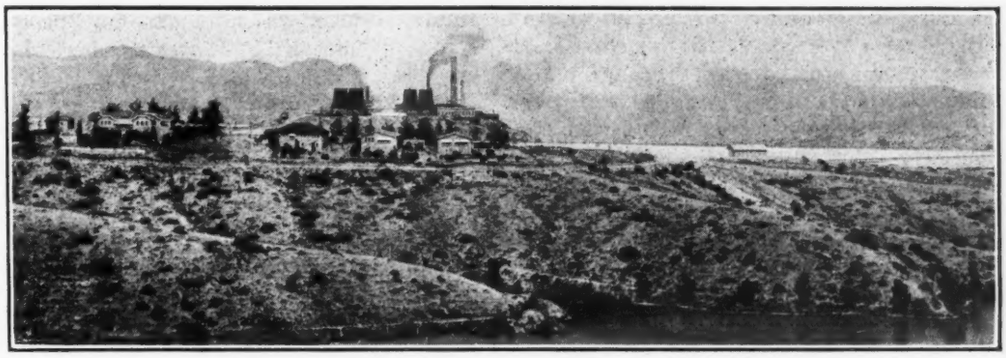
Morenci Undercutting Practice — At Morenci the principal mining work of the Phelps Dodge Corporation is in the Humboldt mine. Incline top slicing was generally used, since the orebody is harder than in mines where undercut-caving is practiced. Incline top slicing has, however, been abandoned and undercut-caving methods are now being tried out. Sufficient success has been attained to indicate that even in the harder and tougher ground of the Humboldt mine undercut-caving is successful. The shrinkage stope and pillar method has been used as well as a new method, called the Morenci timbered-slide method. This method was described in the Dec. 26 issue by McHenry Mosier and John Martin.

(Concluded)

Studies in Slag Formation

Conception of Various Type-Silicates Is Likely To Be Misleading—Compounds Are Essentially Simple, but Have Vast Possibilities of Interaction—Mineralogical Analysis

By Herbert Lang
Metallurgist, Berkeley, Calif.



International Smelting Co.'s plant at Tooele, Utah

THEORIES on the formation of slag in smelting furnaces have been much modified and refined in recent years through investigations which have added much to metallurgical knowledge. Among the investigators have been: Akerman, who in 1886 determined the heat thrown out during the solidification of certain slags; Vogt, who in 1903 published the results of important researches on the formation of crystalline bodies in cooling slags; the Geophysics Laboratory, which interested itself in the equilibrium of simple binary slag systems, its results appearing in 1906; Shepard-Wright-Rankin, who in 1909 furnished similar information on the Al-Ca-Mg-SiO_2 systems; the U. S. Bureau of Mines, which discussed the comparative viscosity of similar bodies at a later date; and, lastly, a very important paper by McCaffery and Oesterle, dealing chiefly with the solubility of sulphides in molten slag, was published in 1923. Briefer but still valuable essays dealing with the same or similar topics abound in the technical press, especially in *Engineering and Mining Journal-Press* and *Chemical & Metallurgical Engineering*, and may be advantageously consulted by the smelting practitioner. Much of the matter is, no doubt, purely theoretical but not thereby the less suggestive. It is based largely on the behavior of very simple slags, composed of few components, especially those prominent in iron smelting, and therefore not so clearly applicable to the more complex products of the copper and lead furnaces, wherein a multiplicity of bases is expected to be present, and from which a multitude of mineralogical forms have already been isolated and described. From the point of view of the mineralogist, the artificial crystals are an interesting novelty mainly, but to the practical metallurgist they present problems not easy of solution, and their consideration may have a closer bearing on the running of furnaces than has hitherto appeared. Meanwhile, more study must be applied to the subjects before comprehensive and useful principles can be adduced.

One of the greatest obstacles to an intelligent comprehension of slag composition is the inadequacy and inexactness of the terms employed in their discussion. As a case in point the expressions "acidic slag" and "basic slag" may be mentioned. Although these are so frequently on the tongues of metallurgists, all that can be said of an acidic slag is that it must be capable of taking up an additional quantity of basic material when fused therewith; and of a basic slag that it can take up additional acidic substance. Beyond this no idea is conveyed, although to the uninitiated it should seem that between the two there should exist a neutral slag incapable of taking up either acidic or basic substances. But this is not so, all the slags of intermediate composition being able to absorb either or both acidic and basic matter. It is a great pity that they exhibit this faculty, since such a neutral slag would afford a useful and convenient starting point from which to begin studies of slag in general.

Oxygen Ratio of Little Importance

In the effort to obtain a working hypothesis, the ratio between the oxygen of the base and that of the acid has been much used, but to little or no purpose, the inquirer never getting beyond the mere fact that in this or that sample a ratio, by no means certain, is found to prevail. Slags cannot be regarded as a single definite chemical compound; rather are they a congress of simpler compounds, of widely different acidity, according to the character of the bases present. Thus, in the majority of slags, and perhaps in all those of a medium range of acidity, there are bisilicates and singulo-silicates; and one may go so far as to say that in such slags the alkaline earths, lime and magnesia, always exist as bisilicates, whereas the heavy metals, so far as can be made out, always exist as singulo-silicates, when they form silicates at all. This consideration alone shows the futility of inquiries into the oxygen ratio of the slag taken as a whole, and also the propriety of the inquiry into its mineralogical constitution. Further, the presence of alumina in many slags

Mineralized Breccias at Calico, Calif.

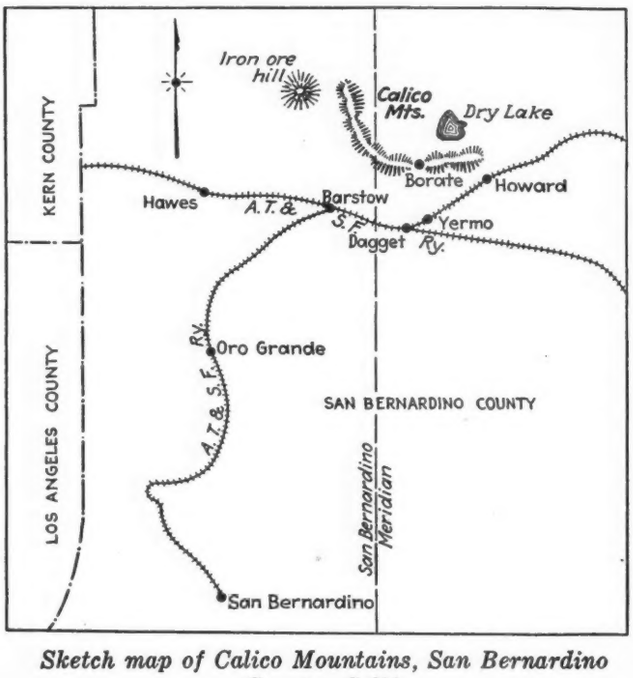
Contain Silver and Lead in Varying Amounts and May Become Commercial Ore

By F. B. Weeks
Daggett, Calif.

RECENTLY I discovered mineralized breccias in one of the old and nearly forgotten mining districts of the West, wholly unlike anything I have seen or read about in a fairly wide experience in the study of ore deposits and their literature. The Calico Mountains in San Bernardino County, Calif., were the scene of active mining operations during the 80's and early 90's, and have produced many millions from their silver and borax deposits. There still remain millions of tons of low-grade deposits that some time will be made to yield a profit.

This desert range of mountains was formed by the intrusion of late Tertiary volcanic materials that broke through the Cambrian and Pre-Cambrian sediments and certain Tertiary strata, known locally as the "Borax beds," and to a great extent covered them with flows, breccias, and tuffs. A considerable part of these volcanic materials is a fine-grained breccia, or in places a tuff, that everywhere carries some silver and often a small amount of lead.

The principal part of the deposit occurs in three large areas and extends along the south slope of the mountains from near the former townsite of Calico and the Silver King mine in a northeasterly direction for nearly two miles to a point near the divide above the former borax operations at Borate, with a width of 300 to 1,000 ft. Another area of apparently the same deposit extends in an east-west direction along and near the summit of the range in the vicinity of the Bismarck mine, one of the large silver producers of the former operations, with a width of 500 to 800 ft. A smaller and more irregular deposit, as indicated by present exposures, lies about the head of Odessa canyon. Probably two-thirds of the whole breccia area (8,000,000 sq.ft.) is exposed, the remainder being covered by surface materials brought down by erosion from the higher parts of the range. At a few points erosion indicates a thickness of 100 ft., but throughout most of the area neither erosion nor former mining operations afford any evidence as to the thickness of the deposit. The breccia is light but compact and would require 15 to 20 cu.ft. in place to weigh a ton. A possible tonnage of 400,000 tons per foot in depth is indicated.



Sketch map of Calico Mountains, San Bernardino County, Calif.

This breccia silver-lead deposit lies in part upon an irregular surface of a dark-colored mudflow. It appears to be a surface flow, though in places it stands up like a dike, due probably to later movements, though there is no evidence of displacement. The breccia, or tuff as it appears to be in some places, is soft but massive in structure in part, and in part occurs in beds several feet in thickness that appear to represent successive flows. Its composition varies in different parts of the mass, markedly calcareous or siliceous, with considerable barite in many places. The mass is not highly fractured, and where fractures occur they are cracks probably due to shrinkage on cooling, though in one place where a depth of 76 ft. had been reached by a tunnel there are well-defined iron-filled cracks.

The principal metallic contents are silver, lead, iron, and manganese. The silver is probably a chloride and the lead is galena that may be a secondary precipitation. Neither iron nor manganese is a prominent constituent, though both are present throughout the breccia mass. The lead frequently occurs as a filling in the cracks, though it is also found disseminated or in small bunches. Silver appears to be disseminated in small but varying amounts through the mass.

Sampling thus far done indicates that silver occurs throughout the deposit and that the lead is of irregular occurrence, but such sampling is wholly inadequate to form a basis on which to determine what parts or how much of the deposit can be made to yield a profit. Samples taken from 5 to 10 ft. lengths vary from 1 to 15 oz. silver. Selected material from the best portion assayed 17 oz. silver and 14 per cent lead. Another sample assayed 10 oz. silver and 12 per cent lead, which when concentrated 6 to 1 by panning assayed 40 oz. silver and 50 per cent lead. A thorough sampling of the surface workings will determine whether a complete sampling of the whole is warranted. Water for core or churn drilling would have to be pumped, but the cost would not be prohibitive.

Ore Amenable to Flotation

Small flotation and table concentrating tests have been made, and an excellent recovery has been secured, but they are insufficient to determine the method to be used or what recovery can be made from the whole or any considerable part of the deposit.

The high-grade material has been mined as shown by many pits, open cuts, short tunnels, and shallow shafts. The character and occurrence of the deposit indicates that as low or lower mining costs can be obtained as are being made anywhere at the present time, when modern methods are applied. Electric power is available within ten miles of the deposit, and with conservation the water supply will be ample for all purposes. Two transcontinental railroads are within four to six miles of the area.

Whether or not the silver and lead values in this fine-grained breccia and tuff deposit are sufficient to make it commercially valuable can be determined only by a considerable expenditure of time and money in complete sampling and in metallurgical tests.

has added measurably to the difficulty, since opinions have always disagreed widely as to its functions, some holding that it always plays the basic rôle, others that it is invariably acidic, whereas the impression that it plays either part, according to the play of chemical affinities, is a view that is gaining ground and is a correct impression, as will be shown. The silicate degree of a slag, taken as a whole, is a vastly different matter from that of its constituent silicates.

Pyritic Slag Worthy of Study

A more promising line of investigation may be made if one bears in mind that it is not the oxygen ratio of the slag, but that of its individual silicates, that is in question. A neutral slag is not to be found, but a slag may be considered which is produced under conditions wherein the different constituents are in a measure free to group themselves according to their affinities. Such is the pyritic slag. This is produced in the presence of an excess of ferrous sulphide, which is decomposed to an extent governed by the silica present, in contradistinction to other slags, which are, as it were, forced to take up all the basic and acidic substances present, without regard to the salts formed, and consequently do not consist of silicates of so definite and ascertainable a nature. The pyritic slag, therefore, furnishes a favorable point of departure from which to begin the study of these products. It is made under conditions which do not vary widely, and which permit the bases to combine with an unvarying proportion of silica, which cannot be said of those slags made from fully oxidized charges, where the bases, iron in particular, are not brought into fusion in any exact proportion to the acid. The result is that silicates of definite degrees are formed, the acidity of which may be discovered by a comparison of analyses. Some of these silicates have been found to segregate from the cooling slag, either in their simple forms, or more often as compounds of simple silicates, and several interesting mineralogical forms have been noted. The composition of these minerals gives a key, as it were, to the internal make-up of the slags, and seems to offer a promising field of study. The conclusion is soon reached that the simple silicates existing in slags are much fewer in number than has been generally supposed. Metallurgists have been in the habit of speaking of mono-silicates, bisilicates, trisilicates and even of quadri-silicates as concomitants of slag, and some have gone so far as to imagine one-and-a-half-silicates and three-quarter-silicates, apparently supposing that the silica can combine in almost any proportion with a given base because they find acid and base in those proportions in the slag. It is true, of course, that in ordinary glass, which is a particular kind of slag, such varied compounds exist, but this is not true of ordinary furnace slags, whose bases, so far as can be learned, have not the property of forming such heterogeneous mix-compounds. The pyritic slag is distinguished from all others by being made up of simple and definite silicates.

Iron the Last Base to Enter a Slag

It would appear, and may be stated as a fact, that all the other bases than iron have to be fully satisfied before any iron whatever becomes scorified and enters the pyritic slag. Proof of this may be given in a variety of ways, especially as to the propensity of the iron to become converted into magnetite, a phenomenon often noticed in pyritic and especially in converter work; and the production, in case of a paucity of silica, of large quantities of matte, which may be lessened by the addition of more silica to the charge. It must be agreed, then, that the stronger bases, lime, magnesia, and alumina, monopolize the acid to the exclusion of the iron, and that their introduction in the smelting mixture diminishes the pyritic effect, however much they may add to the economic success of the work by producing a cleaner and more conveniently handled slag than the heavy, highly ferrous product is found to be. With this conception in mind one may proceed to examine some evidence as to the mineralogical constitution of the pyritic slag, premising that the real evidence is that afforded by numerous analyses.

Dr. Hillebrand's Notable Analysis of Ducktown Slag

Among the published analyses of pyritic slags the most notable is that of the Ducktown slag, made by Dr. Hillebrand, chemist of the Geological Survey, more than twenty years ago. It is notable because made in a sort of competition between a score or more of metallurgical chemists who desired to settle upon suitable methods of analysis, thereby removing the causes of serious discrepancies in their results. It had in a measure the desired effect, no doubt, but not to the extent that might be wished. When one contemplates the character of the analytical work now done it is strikingly apparent that much room for improvement still exists. This analysis is worth reprinting, not that one can build upon it alone a theory of slag formation, but mainly because its discussion will serve to bring out principles of moment in other respects. Taken in connection with other analyses, it shows the facts which lie at the bottom of the theory of slag constitution which I would like now to put forward. The analysis is presumed to be accurate so far as it goes, but it does not go far enough.

Percentage Composition of Ducktown Slag

Silica	33.78	Zinc	2.83
Iron (as metal)	31.68	Manganese	0.41
Alumina	4.07	Copper	0.40
Lime	12.48	Sulphur	1.69
Magnesia	2.87		
Total determined			90.21

Assuming, as I am wont to do, that the alkaline earths, lime and magnesia, are held as bisilicates; the alumina as proto-silicate, $Al_2O_3 \cdot SiO_2$; and the iron as singulo-silicate, $2FeO_2 \cdot SiO_2$; and that the three former must be satisfied before the iron becomes silicated, one must calculate the amount of silica which will remain accessible to the iron, or to the ferrous oxide into which it has been converted. The calculations will be somewhat abbreviated by considering that to form bisilicate of lime, fifteen fourteenths as much silica will be required, whereas three-halves as much silica as magnesia is contained in $MgO \cdot SiO_2$. The corresponding figure for alumina is 60 divided by 102, or roughly three-fifths. So it is quickly found that the 12.48 per cent lime will require 13.35 parts silica; the 2.87 per cent magnesia, 4.3 parts; the 4.07 per cent alumina, 2.39 parts; making a total of 20.04 parts, and leaving 13.74 parts, which must be mainly referred to the iron. Of the iron, 25.64 parts in the form of ferrous oxide will be required to saturate the 13.74 parts silica, leaving 6.04 parts metallic iron in excess, the condition of which demands further inquiry.

It might be suggested that instead of the ferrous singulo-silicate a more basic silicate may have been formed, thereby accounting for more of the iron. This would be a tenable hypothesis, so far as the present analysis is concerned, but the comparison of the many other accessible analyses confutes this suggestion entirely. In no other analysis which has come under my observation is there such a discrepancy between the total amount of iron and the quantity required to take up the silica left uncombined. As a general thing, the excess of iron is small, and in many analyses there is a slight deficiency. In most cases there is an exceedingly close approximation to the quantity of silica demanded by theory, although, in view of the inaccuracies of chemical analysis in general, too great weight should not be given to this concurrence.

Dumping slag pots at Federal Lead Co.'s smelter at Alton, Ill.

The Ever-Present Magnetite

When the Hillebrand analysis was made, nearly a quarter of a century ago, the occurrence of magnetite in such slags was known to but few. W. L. Austin had noticed it in his pyritic slags, and had devised means for preventing its formation in front of the tuyères, which consisted in injecting petroleum with the blast. Herman Keller, at the Parrot works, in Butte, in attempting to bessemerize copper matte with a neutral converter lining of chrome iron, saw the same phenomenon, his vessels being blocked with a mixture of matte, magnetite, and metal; but he failed to grasp the useful significance of the discovery, which was left to others to appreciate. Chemists have been slow in recognizing the presence of and in devising methods of estimating the magnetite when found in slags, and even today they often do not, as they should, report its presence in their ordinary work. It appears, however, to be a concomitant of practically all converter and pyritic slags, and is found regularly also in those of the copper reverberatory. In the latter, when highly ferruginous compounds are smelted, the magnetite usually reaches from 3 to 5 per cent. In converter slags as much as 30 per cent has been found at times. In pyritic work, I have sometimes been troubled by an excessive formation of magnetite, enough to close up tapholes and fill forehearths.

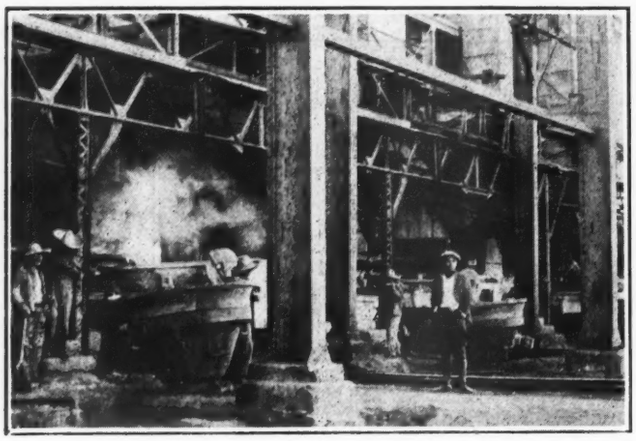
The occurrence generally of magnetite in pyritic slags leads to the conclusion that the excess of iron in the Ducktown slag was due in all probability to the presence of magnetite formed in the casual absence of sufficient silica to saturate all the iron. If the amount of magnetite that could be formed from the 6.04 parts of excess iron be calculated, it is found to be 8.26—an amount seemingly unusual in such connection, but which still may have existed in the slag, the circumstances of whose formation are not entirely known. The quantity of oxygen necessary to form both the ferrous and the magnetic oxides would be 9.48 per cent; which accords with the finding (unexpressed) of the chemist. It will be noticed that his analysis foots up 90.21 per cent, which he fails to conclude with the hackneyed expression "oxygen and loss." The ordinary chemist, so fond of this phrase, may well imitate the reticence of this skillful expert. Between these two estimates, arrived at by diverse means, the discrepancy is little indeed, amounting to only 0.31 per cent.

As if there were not enough uncertainties and complexities attending an inquiry such as this, it is reported that the magnetite found by one investigator in a converter slag fails to conform to the usual formula, Fe_3O_4. This finding, regrettable from one point of view, lends an additional uncertainty to this calculation. However it may turn out, the announcement will at least serve as a warning not to accept too readily the preconceived notion of an earlier time, but to await with patience the orderly progress of science, which will eventually solve all such enigmas.

The Presence of Sulphides in Slag

All slags made concurrently with matte contain dissolved sulphides, whose precise composition has long been a matter of speculation. The analysis cited contains not fewer than five metals, which, on one ground or another, might be presumed to exist, at least in part, in combination with the sulphur, but the precise combinations defeat the present resources of chemical analysis. The five metals are: calcium, iron, manganese, copper, and zinc—all of which form well-known sulphides and all of which have been found in metallurgical products. As for calcium sulphide, which has been found abundantly in basic iron slags high in lime, such evidence as is available does not show its presence in ordinary copper slag, least of all in pyritic slag, which, quenched in water, does not give out the odor of hydrogen sulphide, nor does it tend to weather. For *a priori* reasons it may be concluded, on the contrary,

that manganese does enter the slag as sulphide; and for similar ones it may be suspected that the zinc, wholly or partly, acts the same. As for copper, opinions appear to differ. Some investigators have held that this metal, which is found in all copper-furnace slags,



In the Chihuahua smelter of the American Smelting & Refining Co., Mexico

enters them as dissolved sulphide; others, with some show of reason, ascribe its presence to dissolved silicate. The latest investigators, examining sections microscopically, have found particles of sulphide attached mechanically to particles of magnetite, the two being buoyed up by minute gas bubbles. If this observation is confirmed, it would seem to point to a chemical reaction between the magnetite and the copper sulphide in the absence of air, by which sulphur dioxide is generated, although other explanations may be suggested. This theory finds support by the experience in reverberatory smelting, in which the magnetite formed so extensively in roasting is mostly reduced to the ferrous form by reaction with sulphides. But, on the other hand, it appears to contradict what is known of its behavior in the pyritic furnace and the converter, where it is formed from ferrous sulphide directly, by the action of the air. It is difficult to see how magnetite can be generated in the presence of an overpowering bulk of matte if it be true that the one decomposes the other with or without the agency of free oxygen. Further investigation is necessary to settle these troublesome questions, which may persist for generations.

Sulphides Tend to Vitiate Calculations

The presence of sulphides in slag vitiates calculations to a considerable extent, the more so because one can never be entirely certain of their chemical composition. Matte, as such, cannot be supposed to be dissolved in the slag, though we know that its constituent sulphides are, to a greater or less degree. Suspended particles of matte have been observed by microscopists, but the dissolved matters escape their closest scrutiny. It has recently been found by investigators named in the beginning of this article that temperature exercises great influence on the solubility of manganese and calcium sulphides in iron-furnace slags—the higher the temperature the greater the solubility. From this it may be inferred that copper and lead slags, made as they are at lesser heat than prevails in the iron furnace, would take up less quantities of sulphide, and one may well believe that to be true, though copper and lead slags contain usually not less than from 3 to 4 per cent of such substances of one sort or other. In the analysis quoted, the amount reaches apparently about 5 per cent. It might be thought that the percentage of sulphur would afford a reliable clew to the proportion of sulphide; but this can hardly be relied upon, since it is found that so far as the percentage of suspended matte is concerned, the sulphur bears no fixed and exact ratio to the quantity of matte, it being well known that the sulphur falls, in most if not all mattes, somewhat short of that, due to the presumed composition of the matte. Thus, in mattes which by calculation of the atomic weights of their constituents should contain, say, 28 per cent of sulphur, analysis will probably show only 23 or thereabouts. Hence, in the example given, where 1.69 per cent of sulphur was found, the corresponding quantity of matte remains uncertain, and one can only guess that if it were held wholly in solution it might amount to four times as much, or 6.76 per cent.

It may be to the point to call attention to the faculty that some mattes have of absorbing metallic matters while molten, and of freeing them when cooled. This phenomenon has often been noticed in rich copper sulphides, which take up copper, and, less often, in certain speisses, which take up metallic iron when hot, to precipitate it when cooled. These characteristics make it difficult to arrive at a fixed conclusion as to the real internal composition of mattes, or even as to their actual proportion in a given sample. In the case given, however, one has a check, as it were, on the amount, though not a close one, because, as will be seen, the aggregate percentage of the slag constituents fell short, by 9.79, of 100 per cent—a difference which must be considered only as oxygen. It would not be surprising to learn that the total amount of sulphides ran to 6 or even 7 per cent in view of the results cited, despite the fact that the hotter slags of the iron furnace do not ordinarily contain so much. The subject is one of the greatest difficulty, and the attentive student will realize that furnace slags are bodies of wonderful complexity, containing many a secret in their mysterious depths.

Copper Not an Important Constituent in Slag Under Study

In this particular case it happens that the sulphur present is almost exactly that required to saturate the zinc and manganese present, assuming that it forms with them zinc sulphide and manganese sulphide. The copper is too small in amount to disturb the calculation much, as the sulphur required to convert the copper into the sulphide, Cu_2S, is only 0.09 per cent. Now, since the atomic weights of the three metals, iron, zinc, and manganese, are so nearly equal, it obviously makes little difference to the main calculation whether it be assumed that the zinc and manganese in the quoted analysis existed as sulphides, or were replaced in part by ferrous sulphide, leaving a portion or even the whole of the two former to become silicates. In all probability both were in part scorified, and part of each sulphidized, which makes little or no difference in the main question at issue here, which deals principally with the matter of the silicates in their bearing on the theory of slag formation.

There is no particular reason for believing that the zinc and manganese in the Ducktown slag existed wholly as sulphide, and it is probably only a coincidence that

they are found therein in approximately the proper amounts to unite with all the sulphur as MnS and ZnS. It is more likely that a portion of each exists as silicate, and that some iron replaces them in the collective sulphide. It is convenient enough, however, to regard them as united with sulphur only, since it simplifies the calculations and affords room for further conjecture regarding their actual condition. Copper in slags has been a more fruitful source of study and conjecture, and much progress has been made in the effort to ascertain its mode of combination and occurrence. It has been found to exist in four forms, as entangled matte, as entangled metal, as dissolved sulphide, and finally as silicate. Without going into a discussion of the precise manner in which it is held in the Ducktown slag, which would be more or less fruitless, it may be said that it exists in too small quantity to affect the results of the calculations in any important degree. It may have been dissolved as sulphide, or held in particles of suspended matte, or both. In any event, the amount of sulphur associated with it would have been too minute to have any practical bearing on the main question at issue.

Alumina Either an Acid or Base

The function of alumina in furnace slags has troubled metallurgists for many years. There now seems little doubt that it may act either as an acid or base. Well characterized compounds, forming furnace slags devoid of silica, have long been known, and basic slags low in silica and comparatively high in alumina have been sufficiently studied to make it certain that the latter substance is indeed acid under such circumstances. In slags moderately or highly siliceous, alumina unquestionably plays the basic part, as may be ascertained by a comparison of their analyses. Pyritic slags have been made containing as much as 15 per cent alumina, but even in these there is every evidence to show that it remains basic. Alumina has no such decomposing effect upon ferrous sulphide as has silica; therefore, the addition of silicates of that base to the pyritic charge is irrational, if the intention be to break up sulphides and concentrate the matte. Failure always results from the attempt to carry on pyritic smelting by feeding such aluminous materials as clay rocks, and aluminous silicates generally, if in these there is no "free" or disposable silica. This observation applies equally to all materials in which the silica is already saturated with bases, though of course such materials may contain valuable metals and require to be smelted, and they may subserve a useful purpose also in lightening the slag and rendering the smelting more successful in other ways. Alumina should be avoided in fluxes in every case as having a bad influence in making the slags less fusible and requiring more fuel. A neglect of this principle has resulted in many failures in smelting, some of which have come under my notice.

An Experiment That Failed

In one case a hornblende rock devoid of disposable silica was used to flux cupiferous pyrite, a total and disastrous failure. At this place barren quartz was abundant, and granite might also have been had. The quartz would have produced a slag composed almost wholly of ferrous singulo-silicate, which would have been probably too heavy to allow a clean separation from the matte. This ordinarily would have been corrected as in the case of the Ducktown slag, by the addition of limestone, necessitating a further addition of quartz to scorify it. On the other hand, the granite, which commonly has about 70 per cent silica, and carried also some alumina and the alkalies, soda, and potassa, would have made a lighter slag than the quartz alone and accordingly would have obviated in part the addition of limestone, and so might have proved somewhat more beneficial. Either would have enabled a sufficiently rich matte to be produced, yet neither was thought of, and the matte actually made proved too poor to make the enterprise profitable. Lime is much valued as a slag constituent, and indeed it seems impossible to do really good smelting without it, although it is conceivable that the alkalies, if they were available, might be preferable.

The Ducktown slag may be held provisionally to contain the following minerals:

Mineralogical Analysis, Ducktown Slag

	Per Cent
Wollastonite, $CaO.SiO_2$	25.85
Enstatite, $MgO.SiO_2$	7.17
Andalusite, $Al_2O_3.SiO_2$	6.46
Fayalite, $2FeO.SiO_2$	46.82
(Total silicates, 86.3 per cent)	
Magnetite, Fe_3O_4	8.26
Sulphides, including copper	5.29
Total	99.85

This slag differs from the typical pyritic product in a notable deficiency of silica, and in its excess of magnetite, with a corresponding and doubtless related excess of sulphur. Its specific gravity by calculation is approximately 3.69, whereas that of the sulphide mixture which is assumed, and of the magnetite, are nearly 4. The difference between the densities of the sulphide and of the slag of which it is a component being only 0.31, there is reason for the failure of the sulphides to remain in suspension if any portion of them is in that condition, it being generally held that the difference in density should be not less than a full unit to secure a good separation. It is not to be assumed that the sulphides are here held only in suspension instead of solution, for on that point there is no evidence.

Relation of Magnetite to the Presence of Sulphide

The presence of magnetite may have something to do with the unusual proportion of sulphide. For one reason, its gravity is so nearly that of the assumed matte, and furthermore, in view of the recent discovery that the two react upon each other in the liquid slag, with the setting free of gas the bubbles may tend to buoy up the matte particles, preventing them from subsiding. The only gas which could conceivably be generated would be sulphur dioxide, resulting, in its liberation from copper matte, in the release of the copper in the metallic form, which may then subside or still be kept in suspension. All this seems incompatible with the condition of affairs in the converter, where at times large quantities of magnetite are formed in the presence of great volumes of molten matte, and at a temperature which may exceed the melting point of magnetite, which is understood to be about 1,450 deg. C., at which such a reaction should be at its highest intensity.

The copper content of this slag is as small as can be expected, considering the proportion of magnetite, which is supposed to act prejudicially in this respect. Accurate knowledge on this point is lacking, however, leaving little to be said; but it may be remarked that

On the converter floor, Southwest Metals Corporation, Humboldt, Ariz.

its presence can in no way improve the quality of the slag, though its relatively high density must in a measure, by adding to that of the slag, increase the tendency to hold matte grains in suspension.

Simple Silicates Combine Among Themselves

In view of what has been ascertained as to the internal composition of slag, it cannot be supposed that the simple silicates of which it is composed will remain uncombined with each other. On the contrary, a number of more complex silicates have been found, made up of the simpler ones, which affect each other in a variety of ways. To the eye they form a perfectly homogeneous mass, though the microscope shows it to be anything but homogeneous, many of its members having well-marked physical characteristics. A long list of these substances has been published, substances that have segregated from slags by slow cooling, and yet others remain to be studied. Thus, anorthite, for example, is known to form from the single silicates of alumina and lime. Its formula is $Al_2O_3.CaO.2SiO_2$, and the circumstances of its formation have been studied. The imagination may almost exhaust itself in picturing the possibilities of combination of the comparatively few silicates named as pertaining to the Ducktown slag, and what must be the complexities when instead of these few the bases are numbered by the dozen, as in some slags?

Converter Slag Similar to That from a Pyritic Furnace

From the similarity of conditions underlying the pyritic smelting process and copper converting—the ruling principle, the oxidation of sulphide by atmospheric air, being identical—one is led to believe that a corresponding similarity might be traced between their respective slags. The temperature of their formation cannot differ widely, and in each process there is the same absence of reducing effects. However, the invariably higher percentage of iron in the converter slag, and its higher content of magnetite, are the distinguishing differences. It will be found on comparing the analyses of the two that the ferrous compound in each is the familiar singulo-silicate, and that when lime or alumina exists in the converter charges the silicates formed are identical with the corresponding compounds in the pyritic product.

Some evidence of a different nature may be offered to show that the pyritic slags contain no easily decomposable ingredients such as calcium sulphide and the basic calcic silicates. Thus, when granulated in water, no perceptible sulphurous odor is evolved, wherein they differ from the more basic and calcareous products of the iron blast furnace, which are prone to decompose, evolve hydrogen sulphide, and fall into powder on cooling—a phenomenon due, it is held, to their content of calcium sulphide, and frequently the basic ortho-silicate of lime. Pyritic slags, on the contrary, are of extreme durability, resisting the influence of the weather to a marked degree; whence may reasonably be inferred their freedom from both these constituents. Some pyritic slags made a generation ago still remain as bright and apparently unaffected by the elements as when first cast. Slags of the same average composition, when blown into slag wool, prove remarkably resistant to those influences, in contradistinction to the behavior of the wool made from more basic charges, especially if rich in lime, which tends to decompose when moistened, the fiber breaking down quickly. Tests of wools of different composition by boiling in distilled water plainly show the superiority. This evidence seems to prove the absence of basic silicates as well as of calcium sulphide in the pyritic slags, and hence to render more plausible the views set forth herein as to the mineralogical composition of these slag bodies.

Production of Silicates in High-Temperature Furnaces

When the slag is withdrawn from the pyritic furnace and remelted, as in the reverberatory, it is found capable, as are all slags of medium or basic quality, of taking up additional silica, but with some loss of fluidity, while still presenting a homogeneous aspect. The amount of silica which it can be made to take up will be found to be that needed to transform the contained singulo-silicate of iron to the bisilicate—after which the excess of silica refuses to combine, but remains suspended, forming the so-called "floaters." It appears clear that no higher silicates can be formed at the heats prevailing in the reverberatory, although writers have spoken confidently of tri-, and even of quadri-silicates in this connection. It is possible, however, that at the higher temperatures of the iron blast furnace and of the electric furnace these silicates can be produced, though of this there is no satisfactory evidence. The idea may have taken root from the experience in glass-making, where indefinite but very siliceous compounds containing soda or potassa as the principal bases are produced, the alkalies having a remarkable capacity for fluxing siliceous materials, evidently far beyond that of the alkaline earths or the oxides of the heavy metals.

From time to time have come reports of highly siliceous slags having been made in charcoal-burning blast furnaces; the analyses, if any were procurable, would be of great interest in this connection. Such slags would necessarily have lime as their principal base, and much light might be shed by an investigation of their composition. One cannot expect, however, that the products would be well marked, since they would doubtless always be uncrystallized, after the habit of very siliceous slags. Crystallization, it appears, takes place only in slags of medium acidity, where, apparently, that force has more play.

Discussion

"Engineering and Mining Journal-Press" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief. Letters will not be printed unless the author's name and address are known to the editor.

The Sinking Fund Formula

THE EDITOR:

Sir—I was much interested in the article entitled "Discount Formulas in Valuation of Wasting Assets," written by John A. Church, Jr., consulting engineer, of New York City, and published in *Engineering and Mining Journal-Press* of Jan. 2, 1926, pages 8 to 12, inclusive. Mr. Church refers to one formula used by the valuation engineers of the Income Tax Unit, Treasury Department, in determining values of wasting assets. In his discussion he makes the following statement:

"In the customary formula, this time-honored requirement is met by means of an assumed sinking fund to which net proceeds P furnish equal annual installments F of such amount that at exhaustion their aggregate (with interest compounded annually at rate s) shall exactly reproduce original value V. The remaining proceeds then represent earnings, and V as the dependent variable is so adjusted that the annual earning rate r properly reflects risk."

He further states in the paragraph following:

"With no specific evidence to the contrary, it is always assumed that net proceeds will be received in equal annual amounts, and this assumption is fundamental to the formula.

P = Total proceeds or income.
n = Life of wasting asset in years.
$\frac{P}{n}$ = Annual proceeds or income.
s = Sinking fund rate.
r = Risk rate.
S = 1 plus s.

$$V = \frac{P(S^n - 1)}{n(s + rS^n - r)}$$

Continuing his remarks, he states:

"There is nothing in the premises to show how the sinking fund will be invested, whence s cannot be defined by investment risk and must be fixed practically at the bare rate for the use of money."

A further extract of his reasonings shows:

"When a particular date is selected, the residual life of the asset is known as a matter of course, and this together with the proceeds in reserve can be inserted in the formula (with r and s unchanged) to determine the residual value of the asset at that date. For the same intermediate date the premises also determine the amount of the sinking fund thus far accumulated. And initial value V is obviously represented at this time by the sum of fund to date and residual value, both of them computed solely from the primary assumptions of the formula. If this sum be less than V, the latter may still be a true value, for it can always be recovered from the sinking fund at exhaustion, but if the sum at any time exceeds V, then the formula asserts that after yielding adequate earnings for a part of its total life, the asset and fund together should be liquidated for more than initial value, which therefore must be understated."

Mr. Church then states:

"As a matter of fact the sum of fund to date and residual value exceeds V at all times between the beginning of exploitation and exhaustion."

Continuing his reasoning, he attempts to show by the formula the amount of the sinking fund at the end of a years of exploitation of the wasting asset whose life is n years, and also by the formula determines the "residual life" of the asset over a period of $(n - a)$ years. By a very careful and elaborate mathematical manipulation of his assumed conditions, Mr. Church reduces his conceived factors of "Sinking fund to date" and "Value of residual asset," the former determined on basic date for a years, and the latter at a date a years after the basic date for a life of $(n - a)$ years, to an equation which he calls $T = V + E$, and then shows that E is a positive quantity. In other words, that since V, determined by the formula, does not equal T, the sum of the "Sinking fund to date" the ath year and the "Residual value" determined, as of the end of the ath year for $(n - a)$ years, but is less by E, therefore the formula explained and whose development is shown by Mr. Church is "inconsistent."

Referring to the formula,

$$V = \frac{P(S^n - 1)}{n(s + rS^n - r)}$$

a further simplification can be made by dividing the right hand side of the equation by $S^n - 1$, showing,

$$V = \frac{P}{n\left(\frac{s}{S^n - 1} + r\right)}$$

The last formula form is none other than the commonly known "Hoskold formula," developed in 1877 by H. D. Hoskold, when the first edition of "Engineer's Valuing Assistant" was published.

To get at the root of the question above set forth, I consider that the first and most important thing to do is to refer to the treatise "Engineer's Valuing Assistant," written by H. D. Hoskold, and find out just what the author had in mind when he developed the "double rate" interest formula.

Referring to Hoskold's second edition (1905) of the Introductory Note, written by Peter Gray, the late lamented and one of the ablest mathematicians of his time, the following paragraph reflects the idea of the Hoskold formula:

"It cannot be doubted that the purchaser of an annuity for a term, on which he is to be allowed interest at a specified rate, ought as regards this transaction to be in the same position, pecuniarily at the end of the term, as if he had lent his money during the term at the same rate. The lender recovers his interest annually and has the sum lent returned at the end of the term. But the purchaser of an annuity must recoup himself by investing the excess of his annuity over the annual interest on his outlay, at such a rate that at the end of the term his capital will be reproduced."

On the foregoing assumption, Hoskold developed the formula, as shown by Mr. Church, wherein the sinking

fund rate is less than the risk rate. To illustrate the foregoing assumption, a simple valuation problem is herewith presented:

Given:

Total proceeds, P.....5 years
Life of wasting asset, n.....5 years
Risk rate, r.....6 per cent
Sinking fund rate, s.....4 per cent

To determine V:

Applying the above factors to Mr. Church's formula:

$$V = \frac{P(S^n - 1)}{n(s + rS^n - r)}$$

which is the Hoskold formula in another form. V is found to be (5) (.81757) =4.08785, the capital redeemed at the end of five years. According to Mr. Church's development of the formula given above, the amount placed away each year would be one minus 6 per cent of 4.08785, or .7547290. Then, after the first year's mining, the amount .7547290 placed in a sinking fund for four years at 4 per cent would be (.7547290) $(1 + .04)^4$ or .8829265, and the second annual amount contributed to the sinking fund at the end of the second years' mining would show a value of (.7547290) $(1 + .04)^3$ or .8489675, etc.

(1-(4.08785) .06)	$(1.04)^4$ =	.8829265 =	First	Year's Sinking Fund
(.7547290)	$(1.04)^3$ =	.8489675 =	Second	Year's Sinking Fund
(.7547290)	$(1.04)^2$ =	.8163149 =	Third	Year's Sinking Fund
(.7547290)	(1.04) =	.7849182 =	Fourth	Year's Sinking Fund
(a) (.7547290)	= (a)	.7547290 =	Fifth	Year's Sinking Fund
V	= 4.0878561 =	Total Sinking Fund		

(a) The amount placed away at the end of the fifth year draws no interest.

It can be seen that V, 4.0878561, is merely the summation of the individual "sinking funds," which vary according to the number of years working. It will be noted that the V, as obtained by the foregoing method, is greater by .0000061, which is due to the using of decimal places and can be considered negligible in this discussion. A study of the application of the Hoskold formula as shown above reveals that V is a constant throughout the life of the wasting assets and not a dependent *"variable,"* as stated by Mr. Church in the last sentence of the second paragraph of his article. Furthermore, the principle of the Hoskold formula can be developed for unequal annual amounts and the assumption of Mr. Church that *"equal annual amounts"* are fundamental is not correct, but for simplicity's sake equal annual amounts are considered in the development of the formula.

A further study of the foregoing mathematical set-up shows that the first annual amount placed away in the sinking fund must work continually at 4 per cent during four years; the second annual amount must work continually for three years; the third amount earns interest for two years, while the fourth amount runs for one year and the fifth amount earns no interest but completes the remainder of V. It can be seen very plainly that the formula applies in the determination of the investment for a certain and known period of years and said investment is a constant under the Hoskold premise from a basic and only one date.

Now, following out Mr. Church's suggestion that the sinking fund accumulated to a certain date, say at the end of three years, the intermediate date, plus the residual value of the two years' remaining asset determined under the Hoskold formula, should be equal to the V determined on the valuation made by the same formula under a life of five years, all other factors being equal. Then, according to Mr. Church, the amount placed away at the beginning of the second year earns interest for two years; the amount placed away at the beginning of the third year earns interest for one year, and, according to Mr. Church's idea, the fund ceases to earn any more interest, but this is absolutely contrary to the premise of the Hoskold formula, inasmuch as the premise assumes that the annual amounts placed into the sinking fund must earn interest during each individual period. It can also be said that V, as used by Mr. Church, was determined on the five-year basis, and he proposes to use it only for a period of three years in determining the sinking fund at the end of three years. In determining the value of the two years' asset remaining, Mr. Church proposes a new or revaluation of the asset en bloc over a period of two years, by making the proper substitutions in the Hoskold formula, thus again disturbing the premise of the Hoskold formula, which assumes that the last two years of the wasting asset must be valued at the basic date and not three years hence, as Mr. Church proposes. In other words, Mr. Church starts out with the Hoskold assumption that V, the total asset, is valued on the five-year basis, and then proceeds, contrary to this assumption, to dissect the life and value the last two years' portion on the basis of a two-year life. This is shown mathematically in the foregoing problem, according to Mr. Church, and assuming V was determined by the Hoskold formula on the basis of five-year life.

Sinking Fund

(.7547290)	$(1.04)^2$ =	.8163149 =	First	Year's Sinking Fund
(.7547290)	1.04 =	.7849182 =	Second	Year's Sinking Fund
(.7547290)		.7547290 =	Third	Year's Sinking Fund
Total Sinking Fund	= 2.3559621 =	End of Three Years		

Mr. Church at this point, at the end of three years, proposes that the sinking fund ceases earning interest, although this fund under the Hoskold premise should continue to function in the fund. Elimination of the remaining sinking-fund interest is made by Mr. Church.

Value of Residual Coal

Given:

$P = 2$
$n = 2$ years
$r = 6$ per cent risk rate
$s = 4$ per cent sinking-fund rate.

To determine V, residual value of coal en bloc.

By applying the above factors to the Hoskold formula, the residual value V equals 1.8175320.

Total sinking fund, end of three years =	2.3559621
Value of two years' coal remaining =	1.8175320
Total value — determined by Church =	4.1734941

It can be seen that the value of the two years' coal en bloc, as determined by the Hoskold formula in the previous set-up, is the sum of the last two individual sinking funds of 1.5396472 on the five-year basis and a constant investment of 4.08785, while the value of the same coal determined by Church is 1.8175320 on the basis of two years and an entirely new investment at the intermediate date and not the basic date. This shows an increase of 0.2778848 over the investment of 1.5396472 as determined at the basic date. This difference can be further increased on the assumption that the sinking fund earns additional interest during the last two years, showing a still greater value to Mr. Church's equation built on his assumption.

By again referring to the set-up as determined by the Hoskold formula, the value of the sinking fund for

the three years' depletion must be obtained by the sinking fund to the end of the three years plus the interest compounded to the end of the life of the property.

Sinking fund of three annual payments earning interest for four, three and two years respectively	2.5482089
Value of last two years' coal en bloc (part of sinking fund)	1.5396472
Total investment of capital	4.0878561

Comparison of Results

	Sinking Fund	Coal en Bloc	Total Investment
By Hoskold	2.5482089	1.5396472	4.0878561
By Church	2.3559621	1.8175320	4.1734941

By referring to the comparison given above, it will be noted that Church's sinking fund for three years is less by 0.1922468 than the result obtained by Hoskold, but Church's value of the coal en bloc is greater by 0.2778848 compared with Hoskold's value, so that the net increase of the total investment obtained by Church on his assumptions is 0.0856380. In other words, Church has disregarded the premise of the Hoskold formula by eliminating the compounded interest earned in the last two years of the life of the wasting asset and has increased the original basic investment of the last two years from one based on a five-year life to one of two-year life, sufficiently to more than overcome the loss by elimination of interest, thus showing a greater value of V under his assumption as compared with the V as obtained under Hoskold's premise. Mr. Church then concludes that since his assumptions are equal to those making up the Hoskold premise, and since he obtains an answer greater than the Hoskold result, therefore the Hoskold formula is "inconsistent" and understates value of wasting asset. This is equivalent to saying that $(3 \times 2) + (1 \times 4)$ since

$$a = 5,\ b = 2,\ c = 3,\ d = 1,\ e = 4,$$

then $a \times b = ab = cb + de$ — major premise, substituting,

$$5 \times 2 = 10 = (3 \times 2) + (1 + 4.)$$

Then by assumptions, c and e are changed to 1 and 10, respectively, and by substitution, the right side of the equation becomes

$$(1 \times 2) + (1 \times 10) = 12.$$

Then, since the new assumptions show the right side of the equation to be 12, and since the result is 10 on the left side of the equation, then, therefore, the left side is inconsistent, or 5 times 2 is not 10, which is ridiculous and absurd, and there is only one conclusion, which is that the assumptions on the right side are incorrect and should be consistent with the left side of the equation.

In other words, Mr. Church produces an inconsistency by equating an expression, based upon entirely different assumptions than those used in the determination of the Hoskold formula, with the Hoskold formula. And since his expression is greater than the Hoskold formula answer, therefore the Hoskold formula is inconsistent.

The equation $T - V + E$ is a Church expression and cannot be equated with the Hoskold formula, as the assumptions of either one are not the same.

The question as to how the annual amounts contributed for redemption of capital shall be invested is one for the investor and not for the "premises" set up for development of formula.

The formula of *diminishing investment* as discussed by Mr. Church is also known as the *"simple interest"* formula, wherein, the annual income being constant, and the investment diminishing, the capital is returned slowly in the forepart of the life of the property and increases in the latter part as the investment diminishes.

There is still another formula, known as the "annuity" formula, wherein each annual income is treated as a separate investment and discounted over the period from a basic date of valuation to date when the income is considered due. This formula provides for a large return of capital in the early life of a property and decreasing capital amounts toward the latter part of the life of the asset.

The usage of the formulas given above depends upon the financial policy of the investor.

It has been my experience to observe examples of failures in mining adventure due to inflated speculation, poor valuation judgment, and uncalled-for huge and lavish expenditures of capital in mining properties whose profits are not compatible with the capital outlay. In many cases, large and abnormal *"dividends"* are passed out to the stockholders, who are under the impression that they possess a "healthy paying property," whereas the dividends really compose largely the "return of capital," so that at the end of the life of the mining venture, instead of expecting all or most of their capital invested, the stockholders will find, probably for the first time, that their supposed dividends were in reality their capital invested. So as a matter of protection to the investor, it is my opinion that a sinking fund of some form should be created, and that it should be most conservative in stating the real value of a mining property.

In conclusion it can be said that in determining the true and real value of a mining property, the said value should be governed by *not what has been done, but by what should have been done.*

Scranton, Pa. THOMAS F. KENNEDY.*

THE EDITOR:

Sir—In a recent article on "Discount Formulas in the Valuation of Wasting Assets"[1], the Hoskold formula was charged with inconsistency, not only on mathematical but also on those general grounds to which algebraic analysis supplied a convenient key. Hoskold requires a wasting asset throughout its life to yield some fixed annual return on its initial value, and thus treats this value as a fixed investment, real or potential. On the other hand, periodic resale during exploitation would show a gradually shrinking investment, and since the character of an investment does not depend on the identity of the investor, a wasting asset always represents diminishing investment, whether or not a sale actually takes place.

To restore his fixed investment unimpaired at exhaustion, Hoskold accumulates a sinking fund by annual instalments, each of such amount that at the end of expected life their aggregate, with interest compounded annually at rate s, shall exactly reproduce initial value V. These fund instalments are drawn from the net proceeds of the asset, reckoned after cost of exploitation has been paid, and what remains of the proceeds must then furnish a fixed annual return on V for life at some risk rate r, in practice always greater than s. To derive the Hoskold formula, which is known in the article as Formula 1, it was assumed as fundamental that proceeds are realized in equal annual amounts, whence the fund instalments are uniform. The assumption thus fixes not only the proceeds remain-

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[1] *Engineering and Mining Journal-Press*, Jan. 2, 1926.

ing unrealized at any time during depletion, but also the amount of the fund at the same date. Then the unrealized proceeds can be inserted in the same formula (with r and s unchanged) to find residual value of the asset at that date, all without going beyond the primary assumptions of the formula.

It was shown that if r exceeds s, the sum of residual value and fund to date exceeds V at all times between the beginning of exploitation and exhaustion, whence the formula asserts that asset and fund together after partial depletion are worth more than the undepleted asset. In probing this inconsistency, the excess was found to consist essentially of interest at rate r on depletion to date, and general criticism of the formula was therefore based on the fact that it demands interest on value already restored, no less than on value still inherent in the asset.

In his interesting reply to the article (on pages 491-493), Mr. Kennedy rests the case for the Hoskold formula on three major contentions:

1. The principle of the formula can be extended to unequal sinking fund instalments, whence the assumption of equal instalments is not, in fact, fundamental to its derivation.

Unquestionably a formula on Hoskold's principle can be developed for unequal instalments, but it will no longer be the Hoskold formula of Mr. Kennedy's text and of engineering usage. Mr. Kennedy himself correctly charges Hoskold with developing his formula on the principle of the annuity, which implies uniform annual realization of proceeds and therefore uniform instalments to the fund.

2. My analysis of the Hoskold formula is based on stopping the sinking fund before exhaustion, and since the formula requires a fund working continuously to exhaustion, the analysis violates a premise of the formula.

Mr. Kennedy doubtless refers to my statement that by the Hoskold formula the residual asset and fund to date *can be* liquidated for more than V. The analysis is equally valid, whether or not the liquidation actually takes place.

3. The Hoskold formula provides a series of yearly fund instalments, beginning at some basic date. Each instalment as it becomes available is invested at interest compounded to exhaustion. Value V at the basic date is the sum of all these instalments, each with its interest. Residual value at any subsequent date is the sum of such of these instalments as have not yet become available, each with its interest. Thus residual value must be computed from the original sinking fund series; it cannot be computed afresh from residual proceeds and residual life without violating the premises of the formula.

This is the strongest indictment of the Hoskold formula that I have ever seen. Value is not the summation of a theoretical sinking fund; it is an economic fact. The value of an asset depends solely on the future proceeds, future life, and proper risk rate of the asset at date of valuation. It has nothing to do with the asset's past history or prior condition. The residual value of a partly depleted asset depends solely on residual proceeds, residual life, and proper risk rate *at date of partial depletion,* and on nothing else. Any attempt to define residual value by some prior sinking fund is contradicted by the fundamental conception of value itself. If the correct determination of residual value violates the premises of the discount formula, there is something radically wrong with the formula.

The crux of the discussion lies in these three points. If Mr. Kennedy cannot establish them, his whole structure falls to the ground, and the analysis of the original article carries on. In summary, he objects to the analysis in the belief that it introduces some new feature into Hoskold's premises, forgetting that the statement of a general premise tacitly includes all the special applications of the premise. For example, when Hoskold assumed a sinking fund of specified yearly instalments at specified interest, he necessarily stated the amount of the fund at every moment during its career. When he assumed that proceeds would be realized in specified amounts during a specified life, he necessarily predicted residual proceeds for each moment of that life. When he determined value in general by discounting future proceeds to the valuation date, he determined each particular value by discounting its own group of proceeds to its own particular date.

In thus stating residual proceeds, residual value and amount of sinking fund at every moment throughout life, Hoskold necessarily asserted the consequence—namely, that investment in a wasting asset is increased by partial depletion of the asset. Doubtless he did not realize what he was stating, but his own premises mathematically force him into this position. Many a mine owner wishes that he were right.

New York City. JOHN A. CHURCH, JR.

Take It Plain

THE EDITOR:

Sir—With your permission, I should like to make a few comments on your editorial entitled "Metric Units and Terminology" in the issue of Feb. 13. If the United States should introduce the metric system in 1935, I take it that England and Canada will continue with the present system. In such case, the use of the terms "world yard" and "world pound" could only lead to confusion in our foreign dealings. The metric system is primarily French. Why dress it up in English clothes? Surely, the American people, accustomed as they are to at least three different kinds of ounces, would not be confused by calling the kilogram or the meter exactly what it is. Furthermore, the meter is not a "world yard" nor is the half kilogram a "world pound" by any process of reasoning. To get the maximum value from the metric system, it should be taken just as it is, without any frills. G. W. COTTON.

Parral, Chihuahua, Mexico.

Aid for Claim Owners

THE EDITOR:

Sir—An editorial entitled "Aid for Claim Owners" on page 275 of your issue of Feb. 13, 1926, has just attracted my attention. In support of my belief that an organization other than the Southern Pacific is performing a similar service, I refer you to the questionnaire sent out by the Union Pacific last September. It is quite probable that the answers to same have not yet been compiled, but every patron of the Union Pacific will be quick to challenge any statement that a competing line is doing more for the benefit of the communities which it serves. A. L. SCOTT.

Pioche, Nev.

News of the Week

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary

MEXICO promulgates law relating to export and import of gold and silver. Modification of mining law permits denouncements in formerly prohibited zones.

Pioche, Nev., makes weekly shipments of 2,215 tons—Oatman, Ariz., increases production—Goldfield Deep reports increased ore reserves.

Yavapai County, Ariz., by reason of improved metallurgical methods and better prices, experiences renewed activity.

Howe Sound nets $1,567,765 for year 1925—Idaho-Maryland, Calif., reorganized—Jardine a large producer of arsenic.

Amalgamation of East Rand and Cinderella Consolidated pending.

Virginia iron furnaces allege discriminating freight rates; ask for revision on basis of service rendered the shipper.

Dome engineers return from Red Lake—Mohave Mining plans 500-ton mill—Pioneer mill destroyed by fire.

Pig iron producers apply for increased tariff; India a strong competitor; imports increasing.

Tri-State Development Co. purchases 160 acres of zinc-bearing tract near Joplin.

Appropriation urged for investigation of domestic sources of potash.

United Verde Continues Stripping Over Fire Zone

United Verde Copper advanced another step toward the completion of its stripping program recently when 100,000 lb. of gelatin dynamite was set off in one blast. The dynamite was loaded in two tunnels, the faces of which were 50 and 100 ft. in from the face of a 175 ft. cliff. It is estimated that the blast loosened and made available for removal by steam shovel 150,000 cu.yd. of rock.

The overburden which is being removed overlies the ore body to a depth of 300 ft. Steam-shovel operations have been in progress for five years, and though designed primarily to uncover the fire zone of the mine, have proven profitable, owing to the uncovering of considerable amounts of valuable ore. Other attempts to extinguish the fire which has existed in parts of the sulphide ores for a number of years have been unsuccessful. The two tunnels in which the recent blast was set off were so close to the fire zone that the temperature in the firing chambers was 120 deg. F.

Calumet & Arizona Opens New Ore Deposit at Bisbee

Calumet & Arizona has made two important new finds of ore in its Bisbee property. The largest is above the 1,700 level of the Campbell shaft, where raise No. 64 has disclosed high-grade ore. The raise has been in the ore for 160 ft. and is continuing in it. On the 800 level of the Cole shaft crosscut No. 78 has reached a distance of 100-ft. and is continuing in good grade ore.

Production of Sulphur in 1925

THE production of sulphur in 1925 amounted to 1,409,240 long tons, compared with 1,220,561 tons in 1924. Shipments from mines in 1925 totaled 1,857,970 long tons, compared with 1,537,345 tons in 1924, and were greater by 239,129 tons than the shipments in 1923, the previous year of greatest movement. As in 1924, shipments were considerably in excess of production. Stocks in the hands of producers were thus reduced from 2,700,000 long tons at the beginning of the year to 2,250,000 tons at the end. The estimated value of the shipments in 1925 is $29,000,000. Production from Texas mines was 99 per cent of the total.

Gila Copper Sulphide Co. Sold for $650,000

All assets of the Gila Copper Sulphide Co., whose mine is at Christmas, Ariz., were sold recently at a sheriff's sale and were bid in for $650,000 by attorneys for the stockholders of the defunct organization. The property has been opened up recently and is being operated for the stockholders under the supervision of F. A. Woodward, general manager of the Iron Cap Copper Co., of Globe. The sheriff's sale was resorted to as a means of reorganizing and refinancing the company. About 60 men are employed at the mine, and 100 tons of ore are being mined daily for shipment to the smelter at Hayden.

Superior & Boston Shipped 14,432 Tons of Ore

The report of E. G. Deane, manager of the Superior & Boston Copper Co., Copper Hill, Ariz., for the year ended Sept. 30, 1925, shows that 14,432 tons of ore averaging 3.75 per cent copper and 10.31 oz. silver was shipped to the smelter. For this ore $133,936.15 was received after freight and smelting chrages had been deducted. The ore came from the productive veins in the following proportion: Footwall vein, 35 per cent; Rigby vein, 2 per cent; North vein, 25 per cent; Dewey vein, 38 per cent. Sufficient ore has been opened up in these veins to continue production at the present rate through the third quarter. The amount of development work done was 3,929 ft., compared with 4,549 ft. the previous year. The most important new work of the year has been the deepening of the McGaw shaft 364 ft. below the 1,400 level. The 1,800-level station will be cut as soon as the shaft has progressed far enough below the last contact to insure an undisturbed formation. Electric power has replaced steam on surface and underground, and the electric pumps which will lift the water from the 1,800 level to surface are ready for installation.

February Production at Cripple Creek

Mines in the Cripple Creek district of Colorado during February produced 38,771 tons, with an average value of $8.36 at the Portland mill and $14 at the Golden Cycle. The Cresson mines declared its usual dividend of 10c. per share, payable April 10 to stockholders of record March 31.

Weekly Shipments at Pioche, Nev., 2,215 Tons

Development work will be discontinued at the Prince Consolidated mine, and the pumps pulled, pending the financing of the proposed milling plant to treat the low-grade lead-zinc ores recently opened up by a diamond-drilling campaign from the 835 level. Work will be continued in the adjoining Virginia Louise mine, which is now shipping a substantial tonnage of ore.

About 40 men are employed at the Bristol Silver mines property under the management of Jack Buehler, and rich ore has been opened up on the 700 level west. Three hundred tons of this ore has gone forward to the Salt Lake Valley smelters. The shipments average 35 oz. in silver, 18 per cent lead, and 5 per cent copper.

The Fortuna mine, owned by the Bamberger interests, of Salt Lake City, is being operated under lease by Earl T. Godbe and Silas Thomas. A carload of ore was shipped during the last week to the United States Smelting & Refining Co's. Midvale plant. It averaged 50 oz in silver, and 23 per cent lead, with a small copper content.

The contract system was put into effect at the Combined Metals mine, Pioche, on March 1. Approximately 175 tons daily is now being shipped to the company's milling plant at Bauer, Utah. E. H. Snyder is manager.

The weekly shipments from the Pioche district total about 2,215 tons, distributed as follows: Combined Metals, 1,050 tons; Virginia Louise, 650 tons; Bristol Silver, 250 tons; Black Metals, 225 tons, and Fortuna, 50 tons.

Maxwell Gold Building 100-Ton Flotation Plant

Among the mining properties in the Philipsburg (Mont.) district, which have been "sawing wood and saying nothing" is that of the Maxville Gold, Silver Mining & Development Co., which is under the management of G. W. Quigley. For the last two years it has been developing a group of claims close to the Northern Pacific Railway at Maxville.

Development work includes the driving of a crosscut tunnel 485 ft. long, from which 1,200 ft. of drifts have been run on the main vein, giving backs of 400 ft. An oreshoot 200 ft. long and 10 ft. wide has been opened and averaging $15 per ton in lead, zinc, gold, and silver.

A short distance from the aforementioned oreshoot a second body was encountered recently, which has been crosscut and shows a width of 25 ft., of which 15 ft., on the hanging-wall side, assays better than $20 per ton, with values increasing as the drift progresses and further depth from the surface is attained. The management is of the opinion that the ore showings warrant the erection of an oil flotation plant, and Manager Quigley and I. O. Proctor, general superintendent, were in Butte last week selecting machinery for the plant, which will be of 100 tons daily capacity. It is expected that the plant will be ready to operate by June 1. All machinery is electcially driven, power being furnished by the Montana Power Co.

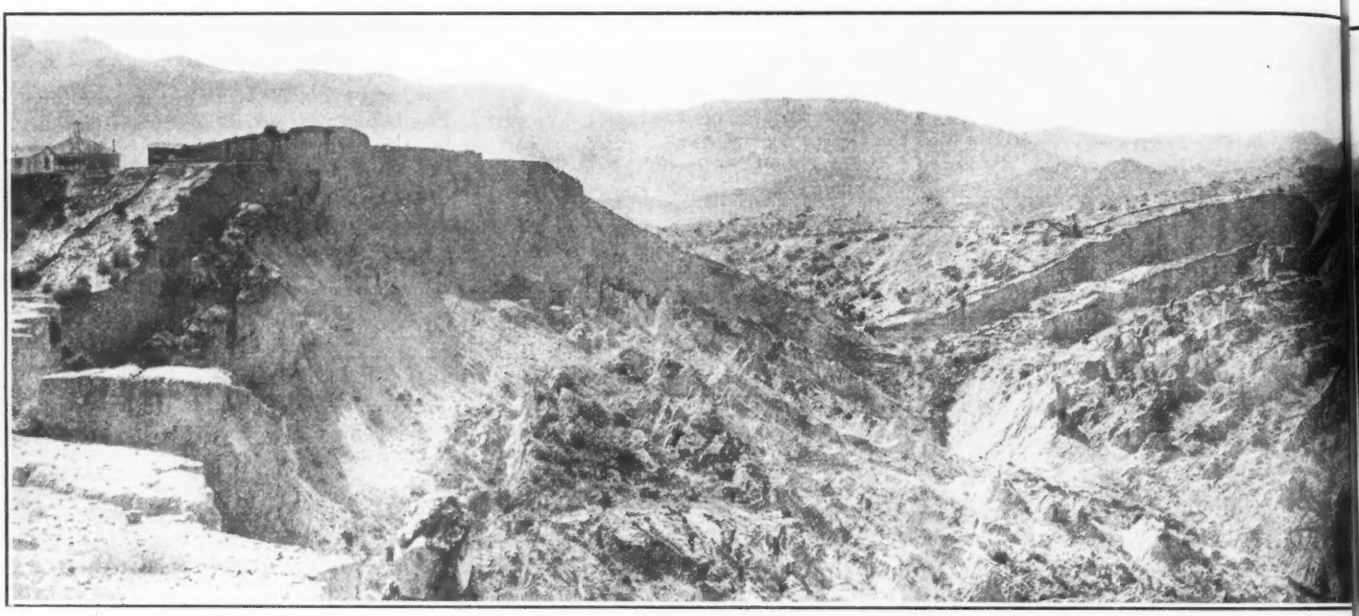
Oatman District Increases Production

Mining activity in the Oatman (Ariz.) district continues to increase. The Tom Reed mill is now handling 100 tons of high-grade ore daily. Most of it is coming from the Shank and other leases on the Tom Reed property and from leases in the Goldroad mine.

At the United Western the surface plant is being electrically equipped and power connections are being made with the transmission lines of the Desert Power & Water Co. The new cyanide mill at the Gold Dust property is nearly ready for operation and the stopes in the mine are in condition to produce.

Howe Sound Has Net Profits of $1,567,765 for Year

The Howe Sound Co., which is the holding company for Britannia Mining & Smelting Co., El Potosi Mines, and Calera Mines, the two latter being in Mexico and the first in British Columbia, has issued its annual report for the year ended Dec. 31, 1925. The growing prosperity of the company is shown by the increases in earnings as the year advanced. During the first half of the year the net profit was $369,398, with a total net profit of $1,567,755 for the full year. Production from the Britannia mine for the year was 29,208,580 lb. of copper; 8,702 oz. of gold; and 143,571 oz. of silver. El Potosi produced 20,451,632 lb. of lead, 4,021,976 lb. of zinc, and 1,815,038 oz. of silver; and Calera, which began to produce in May last, yielded 5,295,974 lb. of lead, 11,074,719 lb. of zinc, and 68,710 oz. of silver.



Panoramic view showing broken surface due to cavi

The ore reserve in the Britannia mine at the end of the year totaled 5,643,712 tons, averaging 2.1 per cent of copper, as compared with 5,719,211 tons at the end of 1924. Development during the year, therefore, approximately replaced the amount of ore mined.

Development in 1925 in the Fair West section of the Britannia shear zone, about 6,000 ft. from the Victoria mine, necessitated the erection of a new camp, with accommodations for fifty men, a compressor, and hoisting plant, and a power line to the camp.

Gray Not Acting in Moulton-Anaconda Litigation

A number of weeks ago it was stated in these columns that the name of John P. Gray, of Coeur d'Alene, Idaho, appeared as attorney on documents filed in the Moulton Mining Co. et al versus Anaconda Copper Mining Co. lawsuit. This is an error, as Mr. Gray's name does not appear on any papers so far filed.

Tamarack & Custer Has Gross Earnings of $260,000

At the annual meeting of stockholders of the Tamarack & Custer Consolidated Mining Co. in Wallace, Idaho, on Feb. 24, the report of the management showed gross earnings for the year 1925 to have been $260,000; net earnings were only $82,000. On the first of this year the company had in round figures $900,000 on hand in cash or convertable securities. Efforts during the year were directed to the development of ore on the new No. 7 tunnel level, 600 ft. below the upper workings, but this work proved disappointing. Production during the year was confined to the upper workings. Recently a promising shoot of lead-silver ore was discovered drifting west on No. 7 level, and the management is hopeful that this will prove permanent and persistent at further depth, as the geological conditions were favorable.

The company owns four adjacent groups of claims which are accessible from the Tamarack workings. One of these is the Sherman, in which considerable ore has been developed and upon which the company recently resumed operations.

At the annual election Jerome J. Day, of Wallace, was re-elected president, general manager, and treasurer.

Idaho-Maryland to Employ "Tributers"

The Idaho-Maryland mine, near Grass Valley, Calif., recently reorganized after the withdrawal of the Whitney interests, will employ several groups of "tributers" in working the property. Electric haulage is to be installed on the 2,000 level.

Operations at the Brunswick Consolidated mine, near Grass Valley, have been temporarily suspended pending additional financing. The mine was operated and is reported to have produced about $8,000 per month during the greater part of 1925.

Mohave Corporation Developing Orebody and Planning 500-ton Mill

The Mohave Mining Corporation, of which J. V. Priest is president, has taken over approximately 1,000 acres of mining ground in the Tidal wave mining district near Twin Bridges, Mont., the nucleus of the present property formerly being known as the Bielenberg & Higgins group. Two major crosscuts are being driven to develop a number of veins which have produced shipping ore in the past.

Possibilities of ore development are excellent, four veins having been cut in the first 600 ft. of work, all showing commercial width and values. Lateral development is being pushed as rapidly as possible, with encouraging results. New compressor equipment to be installed in the spring will permit more rapid development. The crew employed averages about twenty-five men, with H. S. Ayers in charge.

Plans are being drawn for a 500-ton mill, which will be erected during the coming summer. The mill will be built in two sections, one-half of its capacity being designed to treat lead-zinc ore by flotation, and the other section will be used to cyanide gold ore.

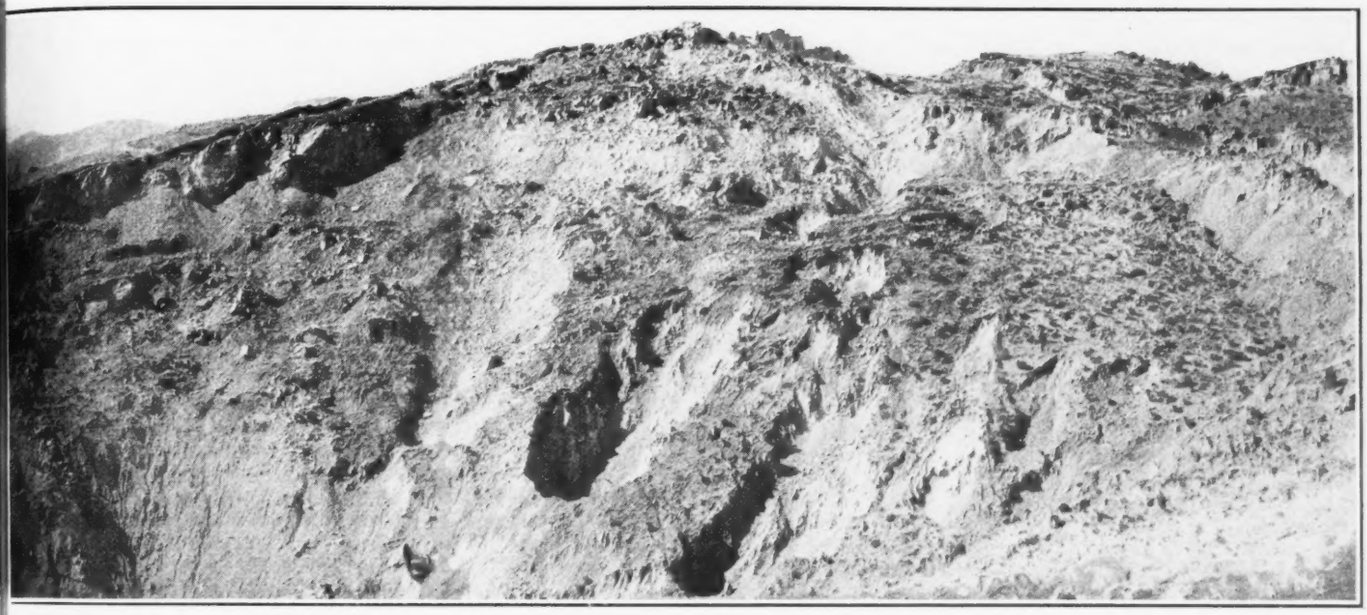
Arrangements are under way to place a dredge on 5,000 acres of placer ground on Fraser River, in British Columbia, owned by the corporation, which has only recently become accessible.

Carlson Exploration Co. Developing Iron Ore Near Grand Marais

Iron ore exploration continues sporadically in Minnesota, the latest work being some drilling on a tract of land about 40 miles southwest of Grand Marais and 9 miles inland from Lake Superior. The Carlson Exploration Co., of Hibbing, is doing the drilling, having secured the contract from a party in Duluth.

Mechanical Equipment at Iron Mines Increases Production

Since the introduction of the small hoist and slusher (scraper) into the iron-ore mines of the Lake Superior region a number of records for loading ore have been established, and the miners are showing intense interest in the work. Recently, at the Newport mine of Pickands, Mather & Co., at Ironwood, Mich., two miners started work in the morning fully determined to make a record that would stand for some time. They worked a full eight-hour shift, and when the day's work was completed they had loaded 108 three and one-half ton cars. This was a total of 378 tons for the shift. These two miners used a small slusher and a double-drum hoist and scraped the dirt a distance of 40 ft. In one mine on the Marquette range production has been increased more than 300 tons per day by adding the slushers, and the number of men employed in the mine remains the same.



produced by underground mining at Miami, Ariz.

Diamond Drill Reveals Extension of Main Goldfield Vein

The diamond drill set up in the bottom of the Goldfield Deep mines shaft continues to show an increasing width of the main vein of the Goldfield district in Nevada. It has already been proved to have a thickness in excess of 200 ft. Owing to the usual difficulties encountered in diamond drilling, the upper part of the hole has been cased and the size of the drill core reduced to only 1⅞ in. in diameter. At times, the formation furnishes a good core, but much of it is friable and crumbles.

A careful study of both the core and sludge obtained from the drilling operations, proves that the vein, where it is being penetrated by the diamond drill, has the same mineralogical and geological characteristics, as was shown by the underground workings in the property of the Goldfield Consolidated Mines Co.

News From Washington

By PAUL WOOTON
Special Correspondent

Pig Iron Producers Apply for Increased Tariff

Commission's Preliminary Report Shows Indian Furnaces as Strong Competitors—Potash Bill Before Congress

In connection with the application of the Eastern Association of Pig Iron Manufacturers for an increase in the duty on pig iron, the U. S. Tariff Commission has compiled a large amount of information bearing on the case. The data have been made available in a 52-page mimeographed report and the case has been set down for public hearing on April 20 in Washington.

INDIAN IRON DELIVERED FOR $19.17

The Tariff Commission's investigators find that high-grade pig iron from British India can be laid down at Philadelphia for $19.17 per long ton. The delivered cost at Philadelphia of Alabama iron is found to be $19.21; of iron from the Buffalo district, $24.59; and of iron from the Eastern district, $21.98.

The delivered cost of Eastern foundry and malleable iron at Philadelphia is $26.42, whereas Continental iron is laid down there for $19.38: United Kingdom iron for $22.18; and British India iron $20.01.

The 1924 total cost of production at domestic steel-works' furnaces is calculated to have been $18.44; total costs at merchant furnaces are shown as $23.52.

Water rates on foreign pig iron, the commission's investigators find, are so low as to give foreign producers an advantage on the Atlantic seaboard and even a greater advantage on the Gulf and Pacific coasts.

IMPORTS INCREASING RAPIDLY

Imports are increasing rapidly, particularly from British India, which produces a superior grade of pig iron and which has thoroughly modern plants. Forty-two per cent of the 1925 imports came from that country.

Since Canada ceased buying pig iron in this country, in 1921, exports have been small, averaging in 1923 and 1924 about one-tenth of 1 per cent of production. On the other hand, imports have risen from 27,000 tons in 1921 to 441,425 tons in 1925.

With regard to foreign iron production, the report says, in part:

"The principal foreign pig iron producing area is tributary to the Lorraine ore deposits and the Westphalian coal fields. Lorraine ore, which is high in phosphorus, produces pig iron that is undesirable for some purposes. European iron-producing countries import large quantities of ore from Spain, northern Africa, Sweden, and at times even from Brazil and Newfoundland.

"The iron industry of Great Britain is next in importance after that of the Ruhr-Lorraine section. Sweden has ample ore resources, but no coal, and produces only charcoal iron, which meets a special demand. India exports about 60 per cent of her production, which was 550,000 tons in 1924, and is therefore an important factor in the international iron trade.

There are large reserves of high-grade ore in India, which has ample supplies of coking coal and cheap labor. Modern blast furnace plants have been built. American consumers of pig iron, at times, are willing to pay a premium because of the high quality of Indian iron.

APPROPRIATION ASKED FOR POTASH INVESTIGATION

Authorization for an annual appropriation of $550,000, for five years, for potash investigations has been recommended by the Committee on Agriculture of the Senate. The Geological Survey and the Bureau of Soils are "to determine the location and extent of deposits or occurrence" of potash in the United States. These agencies also are to study "new and improved methods of recovering potash from other substances."

The bill provides that before undertaking drilling operations the Secretary of the Interior must enter into a contract with the owners of the land and with the holders of the mineral rights, which will provide for the reimbursement of the United States of the actual cost of exploration, in the event that potash or other minerals are found in commercial amounts.

Another proviso requires that all owners of land within a radius of ten miles of each government well must agree to allow the Secretary of the Interior to act as referee in determining the maximum price at which the potash rights may be sold. Those obtaining the rights in turn must agree not to market the potash at a price in excess of a maximum to be determined by the department.

The Public Lands Committee of the House of Representatives has reported favorably on the bill. Potash, originally, was a part of the general leasing bill, but was separated from that measure to expedite its passage during the war.

Important Ruling on Oil Leasing

There have been many cases where various officers, stockholders, and others secure leases on land and then transfer the lease to some oil company, giving the company full rights under the lease. In other words the individual secures the lease, so that he may hand it over to an oil company, thus making the transaction within the law. Eli F. Taylor, register of the Salt Lake City land office, has received the following instructions:

"Where the effect of an agreement, under an operator's agreement in fact, transfers the obligation of the permit or lease, and control thereof, the interest of the operator must be regarded as a direct holding under the act of Feb. 25, 1920."

The ruling means that no company or individual may hold more than one permit on a structure, nor more than three permits in the entire state.

J. M. Johnson, federal supervisor of surveys, and William Spry, of the General Land Office, Denver, will center activities on 140,000 acres between De Beque and Grand Junction, Colo., in Garfield and Rio Blanco counties, making a survey of the oil-shale districts. The work has been sanctioned by Secretary Work.

United Eastern Mills 90 Tons per Day at Jarbidge

THE United Eastern Mining Co., of Arizona, is milling 90 tons of ore per day at its Jarbidge, Nev., property. This company purchased the Bluster and Success groups about a year ago, and has remodeled the mill and developed the mine to the point where it appears a steady production is assured. The ore is a quartz, with principal values in gold and a little silver. About sixty men are employed in mine and mill.

Tri-State Development Co. Purchases Ore-Bearing Land

A 160-acre tract known as the A. W. C. land, situated one mile west of Joplin, has been purchased by the Tri-State Development Co., after several months of drilling and prospecting underground. Consideration was not made public. The A. W. C. mines formerly were good sheet-ground producers, yielding about 3 per cent zinc. It is hoped to bring the recovery to 4 per cent, by modern milling practice. C. W. Dike is general manager.

The Eagle-Picher Co. has taken over a drilling option on the Martha B. lease, owned by R. B. Jensen and associates. It is understood the Eagle-Picher Co. has agreed to pay $50,000 for this lease if the drilling proves satisfactory.

Pioneer Mill Destroyed by Fire

The mill of the Pioneer Lead & Zinc Co., one mile from Cardin, Okla., in the Joplin-Miami field, was destroyed by fire of unknown origin on the afternoon of March 6. The blaze started in the top of the derrick, and although the Picher fire company was on the scene within ten minutes, a strong wind made their efforts ineffectual, except in saving adjoining property. Total loss was announced as $75,000, partly covered by insurance. It is understood the plant will be rebuilt immediately.

Molybdenum at Klockman, Idaho

George Macy and Joel Wells are developing a molybdenum prospect at the head of Meadow Creek, about two miles from the Idaho-Continental mine. The vein is reported to be about 2½ ft. wide. A small amount of ore is now on the dump ready for shipment.

Jardine Mining Co., a Large Producer of Arsenic

The annual report for 1925 of the Jardine Mining Co., operating a gold and arsenic deposit near Jardine, Mont., and one of the largest arsenic producers in the United States, shows net profits of $43,447.19. In the year under review, the company sold gold in the form of bullion amounting to $123,169.65 and in the form of calcined concentrates to the amount of $134,765.47. Arsenic sales totaled $130,505.85. Costs charged against production of and marketing arsenic, which is a byproduct, are given as $57,627.58.

During the year the company drove more than 5,000 ft. of drifts, crosscuts, and raises. The forty-stamp mill was operated continuously, and additional concentrating tables and flotation machines were installed, as well as a 38 x 8-ft. Dorr thickener. Approximately $14,000 was spent in the arsenic plant, increasing its capacity by 65 per cent.

A cyanide plant for extracting the gold from calcines from the arsenic plant was completed late in the year. The company operates its own hydroelectric plant, the cost per kilowatt-hour being .356c. in 1925, against .390c. in 1924.

In regard to the arsenic operations the report states:

"While the improvements in the arsenic plant during the last two years have cut the cost of production 49 per cent, the profit from arsenic production has decreased, as the price dropped from 5¾c. per pound at the beginning of the year to 3¼c. on Dec. 31. The decline is principally due to the decreased ravages of the cotton boll-weevil during the last two years.

"Another use for arsenic which promises to exceed that of all other uses combined is for the preservation of wood. Experiments have been carried on for a number of years by some of the larger companies to determine the adaptability of white arsenic for the preservation of wood, and the results obtained are so successful and encouraging that tests are being made on a larger scale by some of the larger power and railroad companies."

Gold Discovered in Lightning River District, Ontario

A small force is at work in a test pit on the McDermott property in the Lightning River district of Northern Ontario, where some fairly high-grade ore has been discovered. The vein is reported to be rich in gold.

The first gold discovery in this district was made five years ago. Harker Gold Mines, Kirkland Lake Proprietary, and Mining Corporation are interested in the district.

El Tigre Operating at Kerr Lake

El Tigre Combination has opened up some good silver ore on its recently acquired property in the Kerr Lake section of the Cobalt field. Operations are being carried on through a shaft of the Kerr Lake mine, by an agreement with the Kerr Lake Mining Co.

Dome Engineers Return from Red Lake—McIntyre Production Increases

Messrs. John Hammell and D. G. H. Wright have returned from Red Lake. Though a meeting of the Dome directors has been held to discuss this matter, no definite decision has been arrived at, as all of the assays were not available. The matter has been left in the hands of H. P. DePencier, general manager of the Dome, for decision, but there seems to be little question that the option will be exercised. The resampling by the Dome engineers is standing up very well, and in one place commercial ore was found over a width of 66 ft. Rich float has been found in the district, which engineers believe has traveled only a short distance.

Photo by Can. Nat. Rys.

Country rock in the vicinity of Red Lake, Ont., showing veinlet structure

Prospectors are now going in to Rickaby Lake, which lies practically at the Manitoba boundary about 50 miles west of Red Lake. The original claims were staked by the Anglo-Canadian Explorers, a subsidiary of John Taylor & Sons of London, England.

The output of the Dome Mines for February was lower than for a number of months past—43,700 tons were treated, the recovery per ton being $7.54 and the total recovery $329,689. The regular quarterly dividend of 50c. a share has been declared.

The statement of the McIntyre Mines for the quarter ended Dec. 31, 1925, shows gross recovery of $946,688, an increase over previous months.

The directors of the Noranda Mines have issued an official report. There is only one slight change in the original financing arrangements, shareholders being entitled to subscribe for 163,400 shares at $10 a share, which is at the rate of one share for each ten now issued; the subscription privilege expires April 12 and is limited to holders of record of March 20.

Virginia Iron Furnaces Allege Discriminating Rates

Virginia iron furnaces have been made the butt of many changes in methods of fixing freight rates, so that they have been put almost entirely out of business and their markets given to competitors, it is alleged in a complaint for rate adjustments just filed with the Interstate Commerce Commission by the Virginia Pig Iron Association of Roanoke, Va.

Blast furnaces in the Pocahontas region, on the Norfolk & Western and Chesapeake & Ohio railroads, formerly did a prosperous business and sold 60 per cent of their product in the New England and Middle Atlantic states, but at present most of them are idle and can sell practically no pig iron in the East, the complaint sets forth. It asserts that changes in freight rates have given these markets to New York, Pennsylvania, and Alabama furnaces and even taken away markets purely local to the Pocahontas furnaces.

Referring to the history of the Virginia iron industry, the complaint says that when the furnaces were first established it was recognized by the operators and the railroads that they were far from market and that the ore was lean, requiring large bulk shipments, and the railroads agreed that they were neither Eastern nor Western furnaces and that freight rates would be set at the value of the service to the shipper.

Tough Oakes Mills $7.60 Ore

Tough Oakes-Burnside, in the Kirkland Lake area of Ontario, which has just completed a report for the twenty-one months ended Dec. 31, 1925, treated 34,152 tons of ore since the start of mill operations in October, 1924. The ore had an average content of $7.60 per ton, and net mill returns were $309,069.

Revival of Mining in Yavapai County, Ariz.

Improved Metallurgical Methods and Better Prices for Lead and Zinc Responsible

By G. M. Sparks
Prescott, Ariz.

YAVAPAI COUNTY, Ariz., is teeming with mining activity. Adoption of modern methods of treatment, principally that of selective flotation, and the demand for lead and zinc, have revivified all districts of this highly mineralized region. In recent years, much improvement has been made to the roads and highways. General transportation has been improved. The entire district is ideally situated for mining, having ample timber, water, and power.

About 1,500 miners are actually employed in the district, irrespective of the great copper camp at Jerome and the smelters at Clarkdale and Clemenceau. The miner and mining man who has stayed with the "ship" during its lean years carries a smile on his countenance, for he realizes that the cycle of mining has finally entered its own.

Mining means prosperity to Yavapai County, for it is the chief of its industries. During recent years, the tourist has brought great wealth into Arizona, its natural scenic beauties, delightful climates, and excellent highways having attracted visitors from all parts of the world.

The great copper mines of the United Verde and the United Verde Extension at Jerome have made the name of Yavapai famous. Mining of copper in the Verde district is comparable with a large manufacturing concern. It is the opening of new mines, such as the Verde Central, and the opening of the lead, silver, zinc, and gold properties as well as copper prospects in other sections of the county, that bring prosperity to the entire district and state.

Yavapai County has an actual record of production (figures compiled from the U. S. Geological Survey) since 1880 of over $400,000,000.

The revival of mining activity is so apparent in Yavapai County that merchants' windows display mining tools and machinery of all descriptions, advertising to the world that they are prepared to take care of all orders. The majority of miners, prospectors, and operators in Yavapai County have cared little for the term "boom," yet there is no question that the eyes of the mining and investment world are turned toward Arizona.

Mines Not Exhausted

A. C. Gilmore, an experienced mining man of Yavapai County, states: "The mines of Yavapai County are not 'dug out'; in scores of cases they have never been 'dug in'; they have merely been skimmed of their free-milling surface ore, or their high-grade silver-lead ore, while vast quantities of sulphides remain."

Commenting upon this statement, John Harlan, of Prescott, says: "Regarding the 'skimming' above referred to, I know scores of mines and prospects that have been skimmed of their surface ores, for I plead guilty of being one of the skimmers during thirty years of milling practice in and around Prescott."

The Yavapai County Chamber of Commerce Department of Mines has always taken a keen interest in the furthering of the mining industry of Yavapai County. The need at present seems to be for a custom mill located near Prescott, where by means of the selective flotation every mining camp in the county will be active. A survey is now being made by the Department of Mines, through the Chamber of Commerce and Immigration Commissioner of Yavapai County, to ascertain tonnage now available for treatment at such a custom mill.

Railroads Handle Explosives Without Accident Causing Loss of Life

MORE than 500,000,000 lb. of commercial explosives were handled by the railroads of the United States and Canada during 1925 without death or injury to any person, according to a report just made public by the Bureau of Explosives of the American Railway Association. This movement of these explosives was handled in approximately 375,000 cars, but, owing to the excellent work of thousands of factory and railway employees, it was accomplished without accident.

Explosives handled by the railroads during the year included dynamite and other high explosives, black powder, blasting caps, and War and Navy Department shipments.

Index of Mining Claims

A complete index of all patented and unpatented mining claims in Yavapai County has been compiled by the Mines Department of the Yavapai County Chamber of Commerce and is forming the nucleus for the research work which is being done in this direction.

Reflecting the activity which is now apparent in mining, a few of the properties that are being actively operated at this time in Yavapai County may be mentioned:

Resumption of operations at the Southwest Metals Co., at Humboldt, with the blowing in of the smelter. With the active operation of the smelter it is easy to imagine the wave of enthusiasm which is prevailing over the entire Humboldt and Mayer field. The Southwest Metals Co. has been purchasing ore and storing in its bins; likewise, the company has been breaking ore on its own properties, notably the Blue Bell, preparatory to active operation of the smelter.

The mining and shipping of 10,000 tons of zinc ore from the Arizona Hillside Development Co.'s property in the Hillside district has livened up mining in that entire region. The management of the mines is under A. M. Gillispie, with the International Smelting and Mining Co. of Salt Lake City as lessees. The mine is known better as the Copper King. An early-day shipper, and during the war with a record, for the last six weeks prior to the armistice, of a production of 1,000,000 lb., hauled by road for shipment to distant smelters, the rise in the price of zinc has again made it profitable to resume shipping ore. Four hundred and twenty-eight tons of zinc have been shipped up to this time, with fifty tons a day being shipped regularly. The pay streak is about 14 ft. wide. A road built by the zinc owners cost about $50,000.

Hassayampa mining district is another of the wideawake fields in Yavapai County. J. H. Mulrain is actively developing the Sunny South property, a high-grade silver-lead mine opened up as a result of the splendid new Hassayampa Trail, a federal, state, county, and forestry highway built at an expenditure of $2,000,000, connecting Prescott and Phoenix, in a comfortable three and a half hours' auto run.

The Sheldon is an active property and has been the means of increasing activity in the entire Walker field. Lessors on the Sheldon-Superior are making regular shipments to El Paso. The Storm Cloud, now being operated by Goove and sons, is shipping steadily to Humboldt. According to estimates, 23,000 tons of commercial ore can be mined under this lease. The Verde Eastern, in the Cherry Creek district, is thoroughly exploring the holdings of the Verde Inspiration and Jerome Conger. The Gold Note group, owned by George R. Gwynne, is being actively developed, with shipments of high-grade ore. Lute Wilson's Dead Shot property, adjoining the Storm Cloud, has been acquired by W. J. Loring and I. C. Bateman, and a big camp established, amply financed for genuine development. One of the most important strikes made in years is that on the Bodie mine, six miles south of Senator, operated and owned by the Osage Silver & Lead Mining Co. Three feet of rich lead-silver ore is the reward of unwatering a 240-ft. shaft. The existence of this ore has long been known, but the reopening of this old property does go to prove that an idle mine is not necessarily an exhausted mine. Also, it shows the impetus which has been given to mining by the advance in the price of lead. Samuel Fields is largely interested in the Osage company, and is superintending the work at the mine.

The Verde Central has made definite plans for the expenditure of $800,000 in further development work of its property in the Verde district. R. H. Dickson, for the last two years superintendent of the C. & A.'s 85 mine at Valdeon, N. M., has assumed the management of the property. W. F. Staunton, who brought the property to its splendid condition, has undertaken active development of his own attractive property with other Verde Central officials in the Hassayampa district. The Sioux Silver-Lead Co., in the Hassayampa district, is another of the old properties that is making a splendid showing by active development.

London Letter

By W. A. Doman
Special Correspondent

Merger of East Rand and Cinderella Consolidated —Tin Prices Rising

London, March 2—From time to time I have mentioned the rumors circulating concerning the negotiations between the East Rand Proprietary Mines and the Cinderella Consolidated for an amalgamation or a working arrangement. At last there is really something definite to report. A government committee of engineers has been sitting for many months, and has produced a plan to which both parties have agreed. In essence it is that the E.R.P.M. would acquire the Cinderella, with the exception of its cash assets and two electric hoists. But, as further funds are required for working the combined areas, the plan embodies a proposal that the Union Government should guarantee £250,000 E.R.P.M. second debentures both as to principal and interest. The full report of the committee has not reached this side, but the heads of both companies in London are informed that the government declined to guarantee the debentures. The actual purchase price was the new E.R.P.M. second debentures plus 125,000 East Rand shares for the £500,000 Cinderella debentures and one East Rand share for every four Cinderellas. The Minister of Mines has stated that he could not entertain the proposition of the guarantee, as it would create a dangerous and serious precedent to single out a mine and say that it should be helped with the taxpayers' money. Consequently, unless the government changes its attitude, the plan is still hung up. The whole incident seems to indicate that the people behind the Cinderella are doubtful as to whether an appeal to the public for funds would meet with a ready response. Apart from the shares now in the investment stage, Kaffirs are out of favor.

The world's stock of tin being at an abnormally low level, the price of the metal has risen to nearly £296 per ton, and according to the pundits must advance still further, because on the rise consumers have bought only from hand to mouth for months past, hoping to see a drop in price. This has created a rather serious situation. for the demand for the metal must, it is said, show a continuous increase, owing to growing uses for which no efficient substitute has yet been found. As always happens in such cases, new companies are being formed, but whether they will prove successful remains to be seen. Cornwall, at the moment, appears to be doing well, as do also some of the Straits companies, though Southern Perak has proved—temporarily, at least—a disappointment. East Pool is paying a first dividend on its ordinary shares, and great things are expected of this mine.

Some time ago I mentioned that suggestions were afoot of amalgamating the Globe & Phoenix and Gaika (Rhodesia). Rumors have again been put into circulation, and now the directors of the former company have issued a circular to the effect that they do not think there will be any advantage in such an amalgamation.

The National Mining Corporation announces net profits for 1925 of £210,571 and is paying a dividend of 1s. on the 8s. shares.

Foreigners May Denounce Mining Property in Prohibited Zones in Mexico

Individual foreigners will be allowed to denounce mining properties in the prohibited zones, according to a circular recently issued by the Mexican Department of Industry, Commerce, and Labor. All such denouncements had been held up since 1922, but, under the new ruling, denouncements, all other legal requisites being fulfilled, will be put through the regular channels. Though this applies to foreigners as individuals, the same ruling does not apply to foreign corporations or companies of any kind. These companies will come under the regulations of the alien property law.

Mexican Law Promulgated on Export of Gold and Silver

President Calles of Mexico has published a decree amending the present mining law in so far as it affects the exportation of gold, whether coined or coinable. The decree says:

Art. 1—Article 20 of the law on mining taxes of Dec. 21, 1925, is reformed and amended as follows:

"Art. 2—The exportation of coinable gold and of all classes of national or foreign gold coins is absolutely prohibited under penalty of confiscation.

"The Department of Finance and Public Credit may permit, in any case, the export of the old silver pesos with the understanding that, within a period of five days, there be imported for its minting in the national mint, of an equal value in metalic gold.

"The exportation of other silver coins of national minting permitted.

"Art. 3—Article 21 of the aforementioned law is amended to read as follows:

"Importations of silver coins of the present national coinage, that is the silver coins established by the decrees of Oct. 27, 1919, and April 29, 1925, are likewise exempted from the payment of consular fees as well as from consular invoices; but these importations may only be made in each case for sums not greater than one hundred pesos ($100) and by persons coming from outside the country."

Importation of silver coins of all other national mintings is strictly prohibited under penalty of confiscation.

Scale of Wages in Guanajuato, Mexico, Not Satisfactory

Neither laborers nor employers are satisfied with the scale of wages fixed in many parts of the State of Guanajuato, Mexico, by the boards appointed for that purpose, and Governor Enrique Colunga has been asked to appoint them over again and have them go ahead as though nothing had happened.

Johannesburg Letter

By John Watson
Special Correspondent

New Platinum Reef 25 Miles Long May Be Continuation of Lydenburg Deposit

Johannesburg, Feb. 9—The following crushing results for the month of January, from fourteen leading Rand gold mines, have recently been published. The mines are arranged in order of profits earned:

	Tons Crushed	Revenue or Value £	Costs per Ton s	d.	Estimated Profit £
Gov't Areas.....	161,000	302,492	16	4.0	173,622
New Modder....	126,500	274,171	17	6.7	163,117
Crown Mines...	212,000	279,426	18	8.8	80,874
Modder Deep...	44,200	99,758	15	3.0	66,003
Springs.....	67,600	127,206	19	9.2	60,380
New State Areas	73,000	126,299	19	6.7	55,232
Brakpan.....	80,000	128,042	18	5.9	54,094
Van Ryn Deep..	66,400	105,388	16	9.6	50,529
Geduld.....	82,500	119,435	17	0.0	49,322
Modder B.....	63,000	103,748	18	11.3	44,074
City Deep.....	97,000	151,519	22	9.9	40,820
Randfontein Est	200,000	205,705	17	9.2	29,935
West Springs....	47,600	73,797	18	8.6	29,250
Robinson Deep..	74,500	.....	18	1.0	26,230

Dr. Hans Merensky, geologist, is leaving soon on a visit to Europe. Interviewed on Feb. 5 by the mining editor of *The Star*, Doctor Merensky confirmed the discovery of a length of 25 miles of platinum-bearing reef, to the north, southeast, and northwest of Rustenburg. This reef is said to be the same as that occurring in the Lydenburg and Potgietersrust districts. There are minor differences: at Lydenburg the main values are generally on the hanging-wall, whereas the values in the Rustenburg district are always on the footwall of the reef and extend into the spotted norite, underlying the reef, where nests of sulphides weathering to reddish nodules are the indicators for good values. In the footwall of the reef proper, small stringers of chrome indicate commercial mineralization. Dr. Merensky said: "Values, on the whole, are very satisfactory; they can reckon on a good 5 dwt. over stoping widths for long stretches." He felt convinced that the reef would be found over greater lengths and that the Rustenburg district would not take a third place, but would rank equal with other fields. The platiniferous norite rocks near Rustenburg are in comparatively flat country and are covered by 3 to 5 ft. of black turf.

On the Johannesburg Stock Exchange, during the last week, the market has been fairly quiet. Gold shares have improved. T. C. Lands were fairly active and have risen about 1s. 3d. during the week. The 5s. shares of the Premier Rustenburg Platinum Co. were introduced, and by Saturday had sold at 21s. Development is said to disclose good values; vendors' shares, (negotiable only after six months) sold in large numbers at 8s.

Victoria Syndicate Purchases Mining Claims

The Victoria Syndicate has purchased thirteen claims, comprising 650 acres, in the Bulldog Lake gold area of central Manitoba. The price is said to be $250,000.

Situation at the Mines

By Albert H. Fay
Assistant Editor

WITH a slight increase in the price of copper there is a brighter outlook for this metal. Lead, zinc, and silver declined slightly during the month, but there has been no let-up in production; in fact, in the Joplin-Miami district an unusually large number of mills are now under construction which may, ere long, have a tendency to lower prices. As for silver, the mine operators are endeavoring to have the Pittman Act extended.

Average Prices, August, 1925, to February, 1926

Period	In Cents Copper	Lead	Zinc	Silver
August, 1925	14.490	9.192	7.576	70.240
September	14.376	9.508	7.753	71.570
October	14.300	9.513	8.282	71.106
November	14.353	9.739	8.614	69.223
December	13.866	9.310	8.565	68.889
Average, 1925	14.042	9.020	7.622	69.065
January, 1926	13.822	9.255	8.304	67.795
February	13.999	9.154	7.759	66.773

Copper.—The Noranda Mines Co., in Canada, through the Hollinger Gold Mines has completed the financing of its proposed smelter, and work on a 500-ton unit has already begun. Belmont Copper Co., Superior, Ariz., has opened a large body of high-grade ore. Fire destroyed the office of the Superior company at Copper Hill, Ariz. The Mount Morgan mine, in Queensland, has resumed operations as an open-pit mine with a working force of about 350 men, compared with 1,400 last August, when underground mining operations ceased.

The organization of the African Metals Corporation, with offices in New York, has just been completed with the object of establishing a selling agency in the United States for the products of the Belgian mines in Central Africa. A revival of the old Copper Export Association has now taken definite form in the establishment of a new organization with a larger membership and a wider scope of operations. Inspiration Consolidated Copper Co. has issued $6,000,000 five-year 6½ per cent gold notes at par and interest. The proceeds of the note issue are to be applied to the completion of plants now under construction.

The Navaho Copper Co., of Arizona, resumes work and the Kay Copper Co. strikes a new orebody on the 1,600 level. Ironcap Copper Co., in Arizona, has resumed operations, after lengthy litigation. and other Arizona copper companies are producing at a normal rate. The Engels Copper Co. of California, has just closed a prosperous year with an operating surplus of $320,414. Crystal Copper Co. near Butte, Mont., has repaired the recent fire damage, and is continuing development work.

The Granby and the Britannia companies are operating up to the capacities of their respective mills and smelter. Britannia announces that the copper output for last year was 29,208,580 lb., or 600,000 lb. more than the early estimate. Consolidated M. & S. Co. is operating up to the capacity of its Sullivan mill. An interesting feature about this company is the remarkable rise in the quotation for its stock, which now is around $240 for $25 par stock. The outstanding capitalization at the end of last year was slightly more than $12,500,000.

The winter in British Columbia has been exceptionally mild, and seasonal operations have already started at several mines in the West Kootenay district.

Refined-copper production in the Michigan district for the short month of February is estimated at 12,435,000 lb. Of this amount, Calumet & Hecla Consolidated and its subsidiary, Isle Royale, produced 8,535,000 lb. Copper Range output was 1,660,000 lb.; Quincy, 1,000,000; and Mohawk, 1,240,000. Deliveries absorbed all of production, and business on the books for March is good.

Gold.—The principle new activity of the month has been the opening up of the Red Lake district, in Ontario. Excitement in this district is paralleling the early days of other gold rushes. Development work is well under way by three substantial companies, and the ore exposures are promising. Gold occurs disseminated in schists and quartz. There does not appear to be any placer gold in this district. Snow motors have been abandoned and supplemented by the faithful and dependable dog team. The Teck-Hughes mine, in the Kirkland Lake district, Ontario, has opened up additional ore reserves on the 800 level, and the Kirkland Lake mine is continuing to develop the high-grade ore discovered earlier in the year. In California, the Kennedy mine, at Jackson, is stamping 8,200 tons of ore per month and is providing a new hoisting equipment for a depth of 5,000 ft. Plans are under way to rework about two million tons of tailings at the Goldfield mines, in Nevada, and the production of the Tonopah district is declining. West End Consolidated has opened up a new orebody on the 800 level. Diamond drilling at Goldfield deep mines, Goldfield, Nev., promises renewed life to this famous camp.

Lead and Zinc.—In February 181 mills were in operation in the Joplin district, and the number is still increasing, so that there is a serious possibility of an overproduction. The Consolidated Lead & Zinc Co. has become an important factor in Joplin by reason of the consolidation with the Underwriters Land Co. and acquisition of other properties. It now ranks as one of the five largest producers. The Eagle-Picher Co. has increased its holdings in the Miami-Joplin district, and has a 62 per cent interest in the recently organized Consolidated Lead & Zinc Co., so that the two corporations are now producing about 20 per cent of the ore in this district. The Indiana mine, near Picher, Okla., has been sold for $100,000, and other important options are pending.

Lead.—The East Helena (Mont.) plant of the A. S. & R. Co. is to be enlarged to handle the increasing lead ore production of the district. Aerial transportation has been provided for the Pine Creek area in the Coeur d'Alene district, Idaho, by the establishment of a cableway from the mine to the mill. A serious snowslide took place at the Utah-Delaware mine, at Bingham, Utah. It killed thirty-seven persons and a large property damage was incurred. In Southern California there is considerable activity in the new lead district at Leadfield. A number of properties are being developed and a large number have changed hands at high price. The Annapolis Lead Co., of Annapolis, Mo., has been reorganized and plans to resume operations at once.

Iron.—Operations on the iron ranges are on regular winter schedules, a few of the mines conducting stripping operations and the majority of the underground mines working at full capacity. Research work is well under way at the University of Minnesota to determine methods for utilizing low-grade ore. Similar work is just being started at the Michigan College of Mines under the general direction of Dr. W. O Hotchkiss. A syndicate was recently organized to take over options on the Mattewin range 40 miles west of Fort William, Ontario, and exploration work will soon be under way.

Labor Conditions.—At Cananea, Mexico, and other mining districts in northern Mexico the new labor law has to a certain extent stabilized labor. Employers are now trying to find the right man for each job, so that the number of men discharged for inefficiency or inability will be a minimum, the penalty being three months' wages in case of dismissal. At some of the mines the mining companies are introducing a contract system in lieu of the wage system which has been in vogue. British Columbia and other Canadian provinces report satisfactory conditions, with supply and demand fairly well balanced.

General.—At Reno, Nev., mine operators and a number of brokers have formed a mining exchange for the handling of mining stocks. Reduction of freight rates on explosives in Canada became effective Feb. 4, saving the mine operators about $125,000 per year. Offices of the American Smelting & Refining Co., on the thirty-fifth floor of the Equitable Building, in New York, were heavily damaged by fire. The Reynders committee has completed its report on the reorganization of the U. S. Bureau of Mines, and recommends many changes in the scope of the work carried on by the Bureau. Freeport Sulphur Co. is producing at the rate of 400,000 tons of sulphur per year, and with the acquisition of the lease at Hoskins' Mounds, Texas, production is to be increased to 500,000 tons.

Societies, Addresses, and Reports

Idaho Miners Oppose Suggested Change in Mining Laws

The Idaho Mining Association has addressed the following letter to Robert N. Stanfield, chairman of the Senate Committee on Public Lands at Washington:

A special meeting of the Idaho Mining Association was held in Boise, Idaho, on Feb. 11. Over one hundred representative mining men were present. The main subject of discussion was the request made by Secretaries Jardine and Work that you introduce in the United States Senate a bill amending the mining laws applicable to lands within National Forests. After a full and free discussion of the merits of the proposed restrictive measure, the undersigned were appointed as a committee to transmit to you and others interested a resolution embodying the views of the organization upon the vitally important changes that this bill would bring about in the mining laws and in the mining development of Idaho. Over thirty-one of the members present participated in the discussion of the question. It was unanimously agreed and resolved that the adoption of the bill proposed as law would substitute for long-established and well-known and legally interpreted mining laws a series of changeable rules and regulations promulgated, enforced, and interpreted by the National Forest Service.

Since the greater part of the extensive mineral resources of Idaho lie within National Forest boundaries, this measure would have a serious and detrimental effect upon the development of existing mines and would place such restrictions upon the prospecting of the vast mineral zones of Idaho that no prospector would be justified in going into, and probably would not go within, the forest limits.

Endless red tape—bureaucratic supervision—uncertain and whimsical interpretations of the rules and regulations—friction between miner, forest officials, and the public—discouragement of the prospector and the mining developer—all will certainly follow such a useless and radical departure from present tried and satisfactory laws.

In view of the insignificent amount of fraud, loss, or harm affecting the public domain under existing statutes and practices, such a change in the law is unnecessary. It will add despotic power that may be exercised with oppressive and harsh discretion by forest officials. It will extend, without need or fair reason, the power of bureaucracy to stifle, oppress, and crush fair individual freedom of action.

The national industrial requirements for lead and other metals, for which this particular region is noted, are so great that the discovery of new mineral deposits and the development of known mineral zones should be encouraged by the national government rather than retarded by any such innovations as are proposed.

British Columbia Engineers Plan Meeting With A.I.M.E. Section

At the annual general meeting of the British Columbia branch of the Canadian Institute of Mining and Metallurgy, held at Vancouver recently, the chairman, Horace G. Nichols, gave a résumé of mining operations during last year. He considered the most encouraging feature of the year to be the opening up of a large number of small mines. John D. Galloway, Provincial Mineralogist, gave details of the mineral production and exhibited a number of lantern slides, showing recent new construction connected with the industry. Victor Dolmage, head of the Vancouver branch office of the Canadian Geological Survey, outlined the objects of his department and gave an account of the work that was done last year and that which is still under way. H. Mortimer Lamb, secretary of the branch, stated that more than 300 members were now attached to the British Columbia branch. The meeting recommended that the fall convention be held in conjunction with Columbian section of the American Institute of Mining and Metallurgical Engineers, at Spokane.

Michigan College of Mines Alumni Meet at Butte

Alumni of the Michigan College of Mines living in Montana met on Feb. 27 to welcome W. O. Hotchkiss, new president of the College, who is making a tour of the western mining schools with a view to gathering ideas in connection with the teaching of mining and metallurgy and also for the purpose of discussing college affairs with graduates of Michigan. The list of guests was as follows:

L. S. Ropes, Helena; Jay Tuttle, J. J. Carrigan, A. E. Blair, George W. Bennett, W. C. Williamson, Touno Aronen, John C. Gaul, Morgan H. Wright, Joseph P. Nolan, W. B. Bretherton, Alex Leggat, Butte; A. E. Fitzburg, Philipsburg; R. S. Oliver, E. W. Becker, R. A. Case, Anaconda and Dr. W. O. Hotchkiss.

Dr. Hotchkiss declared that advertising was as necessary for an educational institution as for any other line of business, and mentioned the efforts that are being made to bring the school to the attention of the Michigan high school students.

Civil Engineers Hear Paper on Tunnel Construction

A paper entitled "Pipe Tunnel Under Gowanus Canal, Brooklyn, N. Y." was presented by L. S. Stiles, at the meeting of the American Society of Civil Engineers held on March 3 in New York. A number of lantern slides and two reels of motion pictures depicted various phases of this interesting construction, including fabrication, launching, and sinking of the structure.

Galloway Sees $150,000,000 Invested in British Columbian Mines

John D. Galloway, Provincial Mineralogist in British Columbia, frankly attributes the great increase in the values of the mineral production of British Columbia during recent years partly to publicity. Addressing the local branch of the Engineers' Institute of Canada at Victoria, on Feb. 17, Mr. Galloway gave some interesting figures. He stated that the value of the mineral production of British Columbia for 1925 was $61,500,000, of which $47,000,000 was in metals, $11,500,000 in coal and coke, and the remainder in building materials and nonmetallics. Of the lode production 72 per cent was treated in the province, 13 per cent was partly treated in the province, and 15 per cent was shipped to foreign countries in the crude state.

There are 15,000 men employed in the industry, representing an annual payroll of $25,000,000.

Profits derived from the industry are hard to arrive at, Mr. Galloway averred. Dividends do not tell the whole tale: reserves set aside and taxes paid to governments must be added to the dividends. During last year 10 per cent of the value of the gross production was paid in dividends. The total sum invested in the industry in the province is $150,000,000.

In 1924, the last year for which the information is available, the per-capita value of the mineral production for the whole of Canada was $24; that of British Columbia was $93; Ontario, $29; and Quebec, $10.

Joplin-Miami Engineers Plan Club

A movement looking to the early formation of an engineering club or society for the Joplin-Miami district is under way. This proposal was suggested at a dinner attended by the visiting geologists and about 200 mining men of the district, held at the Connor Hotel, in Joplin, on the night of March 2, and received enthusiastic endorsement. On motion of Otto Ruhl, a committee was appointed by P. B. Butler, of Joplin, to work out a plan of organization. He named E. Z. Wallower, Jr., George W. Potter, Victor Rakowsky, and G. B. Corless, of Joplin, and S. H. Davis, P. W. George, and George Stein, of Baxter Springs.

Mining Students at Rolla Hear Prominent Engineers

At Rolla, Mo., on the evening of Feb. 12 the local members of the A.I.M.E. gave a smoker for the student organization of the Missouri School of Mines, the Missouri Mining and Metallurgical Association. The object of the smoker was to give the students a chance to meet personally and to hear short lectures given by Eugene McAuliffe, president of Union Pacific Coal Co.; L. E. Young, former director of the Missouri School of Mines; and J. A. Garcia, of Allen & Garcia, consulting engineers, of Chicago, Ill. These gentlemen in their lectures discussed the things that make engineering the great profession that it is.

Make Mining Stocks Assessable, but Scrutinize Expenditures

Prize Winning Plan in Contest to Help Stimulate Mining in the Northwest—Leo E. Denzel Is Author

The Northwest Mines Investment Co. recently offered prizes aggregating $200 for the best letters suggesting ways and means to stimulate mining in the Northwest. First prize was awarded to Leo E. Denzel of Spokane for the following letter:

We have in the Northwest plenty of excellent mining prospects. All they need is application of sufficient capital to bring them to the producing stage.

On the other hand, there are many large aggregations of capital seeking profitable mine investment, but they generally refuse to give consideration to an undeveloped prospect. They want either a developed or partly developed mine; they lack the individual initiative as well as the courage required to develop a prospect, but will reward handsomely those who achieve a success in doing so.

To bridge the gap between these two provides a solution of our problem.

This cannot be realized without an all-round square deal for the small investors who participate in the financing of mining corporations designed to make a profit by development of prospects to the "near mine" stage, or where the proposition will appeal to the larger aggregations of capital referred to.

In my opinion, the ideal way, because the most equitable and economical when properly safeguarded, of raising money for legitimate mine development enterprises, is through the medium of companies whose capital stock is assessable. To render this method of raising capital acceptable to the investing public and to give them confidence in it, is, in my opinion, the outstanding problem confronting the mining industry, whose solution would have most importance in stimulating Northwestern mine development.

In this connection, pardon a slight digression. In the early days of the Comstock, the stocks of all mining companies were assessable. The way this power to assess the stockholders was abused by the mining operators of that day became such a scandal that an "investors' strike" ensued. To secure any money at all for mining development enterprises it became necessary to work out a plan by which stocks could be made fully paid up and non-assessable. The new plan, when first adopted, worked well, but greedy promoters, by their hoggish methods, very soon had the whole West littered with enterprises that had come to a standstill by reason of exhaustion of reserve of treasury stock, or the inability of the promoters of the various enterprises in question to sell any more of their securities. Another "investors' strike" followed.

Dangers and disappointments due to the abuse of the assessable privilege having been, by this time, generally forgotten, Western promoters in this emergency had recourse to the old practice of organizing assessable companies, and once more found the investing public ready to contribute.

The situation today is that, in the Cœur d'Alene district particularly, there has been in many cases a return to the vicious practices of the old Comstock operators; with the consequence that the public's confidence in this method of raising mine development money has been seriously impaired.

One of the most pernicious abuses of the power to assess is practiced by many company officials in "shaking out" loyal and contributing stockholders. The first step is in forming a combination to depress the market prior to the time set for the delinquent sale, with the object of bringing the price value down to a level corresponding to the amount of the assessment, thus discouraging the holder from protecting his certificate of stock from going to sale.

The conspiracy thus formed is usually carried to a successful conclusion through the assistance of unscrupulous brokers, the latter being compensated for their service by an apportionment of the shares bought in at such delinquent sale, which are usually obtained for the bare amount of the assessment and costs; the conspirators first agreeing in advance upon the apportionment for each participant and seeing to it that no "outsider" is allowed to butt in and "upset the apple cart."

After a large amount of stock is thus obtained at a delinquent sale, the next step is to unload the stock on the public at a profit. This is accomplished by "rigging" and "manipulating" the market in advance before each "unloading" process is undertaken.

These abuses of the power to assess created by mining companies can, in my opinion, be remedied to a large extent by passing a law compelling all assessable companies to file with the secretary of state, or some other designated state official, a sworn statement showing in full detail what has been done with the money raised from each assessment, such reports to cover not only receipts and disbursements in dollars but to show also just what has been done with the money—that is, the amount of "footage" performed—whether by tunnel, shaft, or otherwise, as well as equipment and supplies purchased, in addition to salaries and other overhead expenses. Such financial statement, to carry proper weight, should be audited by a certified public accountant.

The foregoing plan, in my opinion, will automatically eliminate much of the distrust created by wrong methods and abuses of the past with a minimum of state interference with private initiative.

With these teeth in the law governing the conduct of mining companies having assessable stock, it is my belief that the business of being what you term a "professional director" would also lose its attractiveness and that an end would be put to the sudden enrichment of these gentlemen at the expense of their shareholders.

It would also result in quickly restoring the confidence of investors and thus doing much to "stimulate Northwest mine development."

Plan Consolidation of Armour Institute and Northwestern

An important event in engineering educational affairs is the adoption of specific plans for the merger of the Armour Institute of Technology with Northwestern University, which has been effected in order to establish a large Chicago engineering school. A contract effecting this combination, under the name of the Armour College of Engineering of Northwestern University, was recently signed by Dr. Howard M. Raymond and Dr. Walter D. Scott, presidents of the two institutions respectively. The agreement provides for the enlargement of Swift Hall of Engineering at the University and the construction of a machinery hall and two science buildings, all at Evanston, Ill., together with an engineering hall in Chicago for the accommodation of part-time students. For these and other improvements it is planned to raise a building and endowment fund of $10,000,000 by 1930. Actual consolidation will take place at the end of this five-year promotion period. The number of engineering students at present is 744 at Armour Institute (with 781 evening students in addition) and 187 at Northwestern University.

Improvements in Concentration Topic at Rolla Meeting

The Missouri Mining & Metallurgical Association has recently held two meetings at Rolla. L. A. Delano, superintendent of the Bonne Terre mill of the St. Joseph Lead Co., spoke on the subject, "The Psychology of Concentration." Mr. Delano has been a leader in the development of better methods of concentrating lead ores in the Mississippi Valley. The association held a smoker at which a motion picture made by the Bureau of Mines, showing lead concentration in Southeast Missouri, was shown. This was accompanied by a technical discussion of lead milling by Mr. Delano. R. G. Knickerbocker, who has recently returned from Transvaal, gave a reminiscence of his adventures in that place, together with a discussion of the smelting of copper ores in northern Transvaal, where for a few years he had been superintendent of a plant. Both the speakers are graduates of the Missouri School of Mines, and both men interesting talkers. Samuel E. Craig is secretary of the association.

University of Washington to Complete Mining Laboratory

The State Legislature of Washington has appropriated $150,000 to complete th Mines Laboratory building at the University of Washington and to replace the mining building destroyed by fire last December. As completed, the building will be 57 by 164 ft., four stories in height, with steel frame, concrete floors, brick face, and terra cotta trim. It will be thoroughly equipped for mining, metallurgy, coal washing, and ceramics. In addition to providing for the college of mines, the building will also accommodate the offices of the Northwest Experiment Station of the U. S. Bureau of Mines.

Men You Should Know About

A. W. Newberry sailed from New York on March 11 for London.

Walter G. Swart, manager of the Mesabi Iron Co., was recently in San Francisco on a short vacation.

N. W. Bass, of the U. S. Geological Survey, left Washington March 1 for Lawrence, Kan., to resume work in cooperation with the State Survey.

Maurice W. Summerhayes, mining engineer, recently left Toronto for England on professional work. He expects to be away about two months.

Harvey S. Mudd has returned to Los Angeles, Calif., from the Isle of Cyprus after six months' examination work there. During his absence he also spent some time in London.

Colonel Robert W. Stewart, chairman of the board of directors for the Standard Oil Company of Indiana, with many of the company's executives visited Denver on March 9.

Hal M. Lewers, chief metallurgist for the Tonopah Belmont company at Tonopah, Nev., has returned to Tonopah from a trip of several weeks to Arizona and Utah for his company.

C. W. Moore, formerly of the Oliver Continuous Filter Co., has returned from the Columbia Chemical Co., Barberton, Ohio, to the New York office of the Oliver company.

Captain J. F. Lucey, of Dallas, Tex., president of the Lucey Petroleum Corporation and chairman of the standardization committee of the American Petroleum Institute, was in Houston, Tex., recently.

A. F. Brigham, general manager of the Consolidated Gold Mines, Limited, has been appointed consulting engineer of the Amulet Gold Mines. He will be in full charge of all future developments of the company.

Ernest Clark, a student of the petroleum technology course, Royal School of Mines, Imperial College of Science and Technology, has been awarded the Students' medal and prize for 1925 for his paper on "Organic Theories of Oil Origin."

C. H. McCarthy-Jones has been awarded the Boverton Redwood Medal for Sessions 1923-24 and 1924-25 for his paper entitled "Electricity Applied to the Winning of Crude Petroleum, with Special Reference to the Yenang-yaung Field, Burma."

H. C. Dudley, vice-president of the Ahumada Lead Co. and president of the San Miguel Mining Co., and **W. G. Swart,** vice-president and general manager of the Mesabi Iron Co. recently made a visit of inspection to the Ahumada and San Miguel mines.

Enoch Henderson, a graduate of the Michigan College of Mines, Houghton, has accepted the superintendency of the Iron Dyke Copper Co. at Homestead, Ore., of which **Dr. Walter Harvey Weed** is manager. He will leave Houghton soon to assume his new duties.

Philip S. Smith, of the U. S. Geological Survey, reports that his party left Nenana, Alaska, on Feb. 27 with two dog teams, that everything was well with the party, and that the weather was cold but the trail good. He expects to reach Kotzebue about March 21.

D. F. Hewett, of the geologic branch of the U. S. Geological Survey, sailed from New York on March 12 for Greece, and will go to Spain by way of Italy and Sardinia, for the meeting of the International Geological Congress. He will be absent about five months.

Dr. Willard Rouse Jillson

Dr. Willard Rouse Jillson, Director and State Geologist of Kentucky, has recently presented to the University of Louisville, Louisville, Ky., his private collection of geological specimens consisting of several hundred rocks, fossils, and mineral ores.

Thomas C. Wasson, a vice-consul for the United States in Australia, has visited the Adams River osmiridian field in Tasmania, with a view to studying its possibilities. It is thought in Australia that there are good prospects of a market in America for Australian osmiridian.

J. Edgar Pew, of Dallas, Tex., vice-president of the Sun Oil Co., and past president of the American Petroleum Institute, has been elected president of the Beacon-Sun Oil Co., which has large holdings in Venezuela. Accompanied by **Dr. F. H. Lahee,** chief geologist, Mr. Pew recently left Dallas for an inspection tour of the Venezuelan properties.

John P. Leary and **Lawrence H. Sonneborn,** who for many years had been connected with the American Smelting & Refining Co., have formed the firm of Leary & Sonneborn, Inc., with offices at 133-137 Front St., New York City. On March 1 they began business as metal and chemical brokers. Mr. Sonneborn is a graduate of the School of Mines, Columbia University, and has served the American Smelting & Refining Co. in both technical and sales capacities. Mr. Leary has been in the sales department of the American Smelting & Refining Co. for the last eighteen years.

Obituary

Eric Oscar Kamm, manager in Galveston, Tex., for the Texas Gulf Sulphur Co., died on Feb. 27 at Gulf, Tex. He was forty-three years old. Mr. Kamm had formerly been connected with the Consolidated Mining & Smelting Co., the Mason Valley Mine Co., and the Magma Copper Co.

Edward W. Stebbens, mining engineer of Denver, Colo., died March 4. Mr. Stebbens was a native of Stratford, Ontario. He was born in 1855, and came to Colorado forty-five years ago. He was known as an excellent engineer and was engaged in many large projects in Colorado and Mexico. His widow and one son survive him.

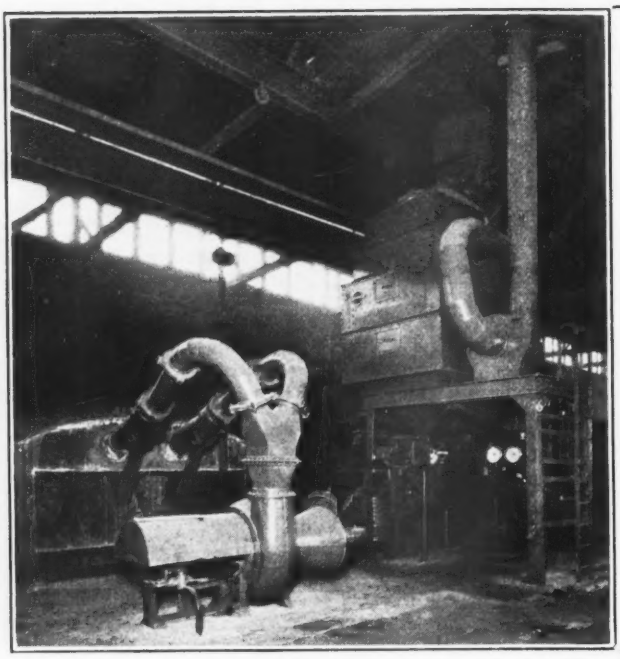
George M. Holbrook, of Toronto, a prominent mining man, died in Toronto recently. Mr. Holbrook, who was in his sixty-third year, was born in Boston, and had lived in Toronto for the last twenty years. He was associated with a number of mining activities, and was very well known in the mining circles of Toronto and northern Ontario.

William Griffith Tretheway, one of Canada's most prominent mining men, died at Sarasota, Fla., on March 6. Mr. Trethewey, who was one of the discoverers of the Cobalt silver mining district, was sixty years old. He was born in the District of Muskoka, Ontario. After working the Trethewey mine successfully for some years, he sold his interest, and in 1913 took up his residence in England. After the war he sold his English estate, returning to Canada two years ago. He is survived by his widow and two sons.

Thomas Henry Tregonning, a foundryman and an inventor of mining machinery, died recently in Cornwall, England, at the age of ninety-six. Two devices designed by him have been in use in mining districts around the world for many years. One is a dipper wheel, designed to raise tin-bearing slimes from mine streams, and also a pulverizing device, which is said to have been the forebear of the now well-known tube mill. Six sons, all mining men, survive. Three are in South Africa, one is in New York, one in England, and one in Grass Valley, Calif.

Phil M. Collins, mining engineer and metallurgist, died at his home in Miami, Okla., on Jan. 12, 1926. He was born in Georgetown, Colo., on June 22, 1872, and was graduated in 1894 from the Colorado School of Mines. He was widely known and was an able, experienced man. Mr. Collins was superintendent of the Portland Gold Mining Co. in 1902. In 1910 he went to Basin, Mont., and had charge of the experimental plant of the Butte-Superior Copper Co. He designed and afterward operated the Butte & Superior mill at Butte, Mont., in 1912. Later he went to British Columbia for the British Columbia Copper Co., returning to the United States in 1917, where he installed flotation equipment in different plants in the San Juan district. He took up his residence in the Tri-State district in 1921, where he was for a time employed as superintendent of a zinc property.

New Machinery and Inventions



Unit system of firing pulverized coal applied to 25-ton melting furnace in plant of Kuebler Foundries, Inc., Easton, Pa.

Coal Pulverizer Connected Directly to Furnace

A new type of coal pulverizer directly connectly to the consuming unit and known as a multi-stage unit pulverizer has recently been introduced by the Grindle Fuel Equipment Co., Harvey, Ill. The chief purpose in designing this pulverizer, according to the company, was to develop an efficient means of pulverizing coal for direct firing of boilers, melting furnaces, annealing ovens, core ovens, billet or bar heating furnaces, and similar units. It is also intended to be used for pulverizing pigments, chalk, charcoal, foundry facings, fuller's earth, and like materials. An effort has been made to produce a pulverizer that will operate at a reasonable cost for power and maintenance.

The pulverizer consist of a series of swinging hammers mounted in five stages. The vertical shaft is driven by a direct-connected 1,800 r.p.m. motor. The housing which fits over the beaters has corrugated steel rings on the inside, which clear the swinging hammers or beaters by about three-sixteenths of an inch. The crushed coal (1½ in. or under) is fed from a hopper onto the belt feeder. This belt passes over a magnetic pulley, which removes the tramp iron. The coal then drops down the feed chute and falls on the top disk or stage of the pulverizer. Any foreign material, such as brass, wood, slate, or iron pyrites, which passes by the magnetic pulley, is thrown out by centrifugal force on the first or top stage and deposited in the foreign material box at one side of the pulverizer. The high speed at which the disk is revolving throws the coal out against the corrugated rings of the housing. On the rebound the beaters strike it, pulverizing it fine enough to pass down to the next lower stage, and so on until it reaches the discharge chamber.

An advantage claimed for the pulverizer is that it can be arranged to furnish a very low volume of air at a relatively high pressure for blowing coal from the discharge chamber to the point of consumption, thereby overcoming the common fault of having more air than necessary for perfect combustion at low ratings. When the pulverized coal is being separated for storage, only small volumes of air are handled, requiring a smaller capacity of collecting apparatus than is ordinarily used.

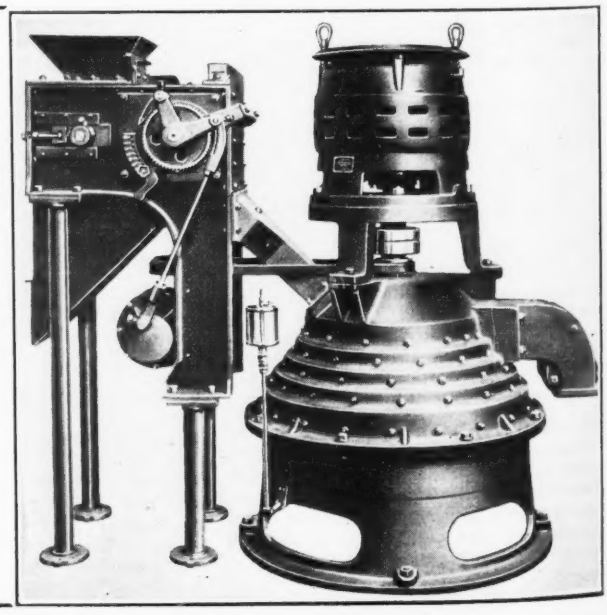
The swing hammers are reinforced at the point of greatest wear and are reversible. The pulverizer rotor turns in S-K-F self-aligning ball bearings, which are lubricated by an oil cup. Feeder bearings are lubricated by high-pressure grease system.

Among the advantages claimed for this pulverizer is that it eliminates hand-firing, reduces labor, and saves time, fuel, and furnace lining. It is claimed that it is absolutely safe, because the pulverized coal is not mixed with large volumes of air until it enters the burners, and on account of the velocity of the coal-and-air mixture through the burners it is impossible for the flame to flash back. The mixture of air and coal in the conveying lines is non-combustible. In operation, the pulverizer is said to be practically noiseless and dustless. The unit is very flexible, inasmuch as the rate of firing can be changed instantly, as the load demand changes.

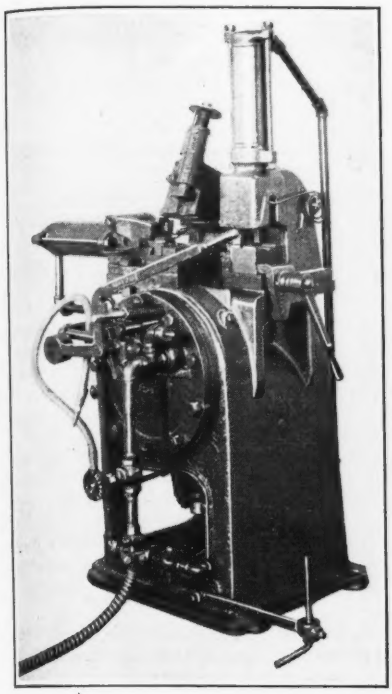
One of the accompanying photographs shows the unit system of firing pulverized coal applied to a 25-ton melting furnace in the plant of the Kuebler Foundries, Inc., Easton, Pa. The vertical drier is shown together with the multi-stage unit pulverizer, the volume exhauster and burners.

All-Hammer Drill Sharpener Light and Compact

Rock drill users sometimes require a drill sharpener that is sufficiently light and compact to be easily moved and that is able to make ordinary hammer drill steel bits and shanks effectively. Among them are the smaller mines and quarries, road contractors, and the like. To meet this need the Sullivan Machinery Co., Chicago, Ill., has developed the so-called Type C all-hammer sharpener, which weighs only 1,000 lb. and occupies a floor space of only 3½ x 2½ ft. It may be mounted on timbers or skids and is easily moved when necessary. It is capable of making and resharpening any ordinary hammer drill steel up to 2½-in. gage, and of forging collar or lug shanks. All operations, both upsetting under the dollies and swaging or dressing out the wings, under the vertical dies, are performed by hammer



Multistage unit pulverizer and feeder with magnetic separator, complete with motor and drive. Note the five horizontal stages



This sharpener can be readily moved. It makes ordinary hammer-drill bits and shanks effectively

action, with the powerful, fast hitting, horizontal, and vertical air hammers. It possesses all the equipment and attachments needed for effective bit and shank making, including a positive gaging device, to assure correctly formed "double taper" wings, and accurately sized bits, according to the manufacturer.

The sharpener, as shown by the illustration, consists of a substantial, cast-steel frame on a pedestal, on which are mounted the horizontal hammer for upsetting and the vertical hammer for swaging. In the base is contained the vise or clamp for holding the steel while being dollied and the diaphragm and toggle which furnish the power to operate the clamp. The horizontal and vertical hammers are similar in type and action to those standard on older Sullivan sharpeners. Heavy springs are used to retract the dolly and to lift the upper vertical die from the steel when air is shut off. Dollying is controlled by a hand lever and swaging by a foot lever, the two interlocking, so that the vertical hammer cannot strike while the vise is closed. An adjustable bit-gaging device is provided similar to that used on the older machines, for accurately gaging the wings and for enabling a true double taper to be given the bit. This gage is mounted on a substantial hinge, which permits it to be raised out of the way when not in use, affording a clear view of all the working parts.

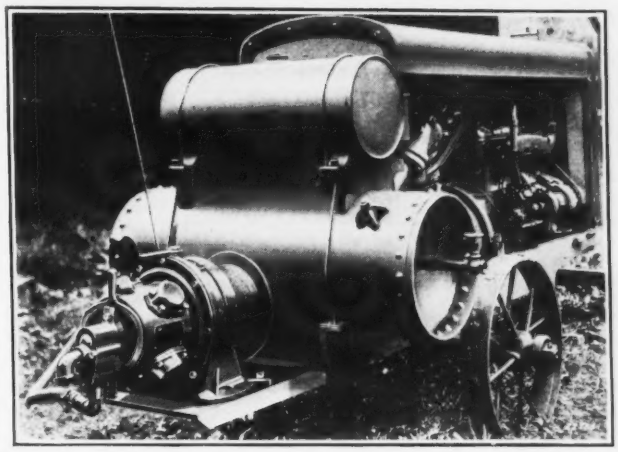
Agent Appointed

The Colorado Iron Works has been appointed exclusive agents for the Gilman Manufacturing Co. in the intermountain district. It maintains offices in Denver and Salt Lake City.

This Air Hoist for Use With Portable Compressor

An air motor hoist of a new size has been added to its so-called DU Utility line by the Ingersoll-Rand Co., 11 Broadway, New York. This size has been especially designed for use with portable compressors and is suitable for a wide variety of work. It is a hoist of general utility and can be used for any of the pulling and hoisting jobs which are continually presenting themselves. It may even be used for hauling the compressor itself a short distance. It is a light, compact hoist of the winch type and is provided with mountings by which it may be attached to the rear end of a 5½ x 5-in. or a 5 x 5-in. portable compressor, to the side of the larger compressors, or to compressors mounted on Ford trucks. In such cases it is always ready for use and adds but little to the over-all dimensions and weight of the compressor. It is capable of exerting a rope pull of 1,000 lb. and of taking 350 ft. of ⅜-in. cable. A swivel bolt through the bottom of the base permits the hoist to be swung around into any desired position.

Utility hoist mounted on rear end of 5½x5-in. portable compressor



The hoist is equipped with a clutch so that the cable can be easily played out by hand or by a down-grade load without turning over the motor and consuming air. A hand brake on the drum is provided to check the unwinding and stop it in any desired position. The throttle control is sturdy and sensitive so that any speed of rope travel can be obtained—from the very slightest movement up to a maximum speed of 65 ft. per minute, although carrying full load of 1,000 lb. at an air pressure of 80 lb. per square inch, according to the manufacturer. A winch head can be furnished in place of the rope drum.

A New Water-Tube Boiler for Oil Field Work

An improved type of water-tube boiler of the curved-tube type is described by the Southwestern Engineering Corporation in a recent bulletin. The boiler consists of three horizontal drums, the upper front drum being integral with a water leg to which are attached two banks of water tubes, the upper bank connecting with the upper rear drum and a lower bank with the mud drum which is also connected by vertical water tubes with the upper rear drum. Feed water enters the upper rear drum and passes downward through the vertical tubes to the mud drum and then rises through inclined tubes to the water leg, returning to the feed-water drum. A large combustion chamber is provided, baffles directing the heated gases through the several banks of tubes. Steam is taken from the upper front drum.

The water element of the boiler, drums and tubes, is suspended by the brackets on the ends of the upper drums, leaving the structure free to expand or contract. The boiler housing is constructed of firebrick and ordinary brick. Special hand-hole caps are provided for giving access to the principal tube bank for cleaning. The boiler can be built for high pressures and in sizes from 80- to 2,500-hp. units. A portable unit, 80 hp., is also constructed. The over-all dimensions are 12 ft. high, 14 ft. long, and 7 ft. wide. Foundations are alone necessary for the installation of the portable unit. A steel casing in panels, lined with heat-resisting materials faced with refractories, forms the boiler housing. The stack is supported upon the steel frame. The unit weighs about six tons and is self-contained with stack, steel casing, steel supports, and fittings. Boilers of this type are used in oil field operation, and in this service have proved to have large overload capacity.

Trade Catalogs

Water-Tube Boilers—The Southwestern Engineering Corporation, of Los Angeles, Calif., has issued a bulletin describing the Collins water-tube boiler in stationary and portable types.

Diamond Drilling—E. J. Longyear Co., Minneapolis, Minn., has issued a bulletin (No. 26) entitled "Rock Products Development," discussing diamond core drilling and mining in the nonmetallic field.

Well Drilling Machinery—The Okell Well Machinery Corporation, of Los Angeles, Calif., has issued a catalog of oil- and well-drilling machinery, including the portable rotary drilling type and combined rotary, core, and churn drills.

The Market Report

Major Metals, Except Lead, Are Higher

Cut in Lead Price Stimulates Business—Copper and Zinc Sales Only Moderate—Spot Tin Scarce

New York, March 17, 1926—Purchases of lead in large volume following the reduction to 8.20c., New York, featured the week ending today in the non-ferrous metal markets. The market appears to be somewhat firmer. Zinc and copper likewise showed strength yesterday and today, although the volume of business during the week has been only moderate. Tin is active, with consumers in the market and prices at new high levels since August, 1919.

Copper Seems Stronger

Although some sellers were willing to take business at 14.125c. delivered during most of the week, others have been holding firmly at 14.25c., and have done only a limited business. Several good sized sales for the Connecticut Valleys brought 14.20c. and at least two large lots for Middle Western delivery are reported, on which 14.375c. was realized. Business has been done in Europe on a basis of 14.125c. and 14.15c. f.a.s for May-June delivery and at 14.40c. c.i.f. Most of the domestic business has been for April and May, though some sales are for later delivery. Statistics show an increase of 5,633 tons in combined blister and refined stocks at the end of February. Likewise, the daily rate of mine production increased during February. These seemingly bearish factors do not appear to have had a bad effect, however, and the strength from London has helped support the domestic market.

Lead Sales Larger

Following the reduction in their contract price of lead, made by the American Smelting & Refining Co. last Wednesday, which brought the New York price to 8.40c., the market continued inactive, and a further reduction, to 8.20c., was made on Friday, March 12. London, however, advanced on each of the last four business days, and this stronger tone abroad has given a distinct fillip to the domestic market. A fair tonnage was sold on Saturday, and on Monday producers were flooded with inquiries, many of which resulted in sales on that day and yesterday. As a result, the total volume of lead sales for the week ending today has been the greatest in several weeks, with practically all sellers sharing in the business. April shipment has for the most part been specified, though a good tonnage of March has also been sold. March is becoming rather scarce now, with some sellers quoting premiums for early shipment. A small tonnage of prompt lead was sold today as high as 8⅜c., New York.

In the Middle West, all of the principal sellers have sold at the 8c., St. Louis, and 8.05c. Chicago, levels, for practically the entire week. Today, no change in their attitude was reported, though one producer said that he was making no more quotations, having little left to offer.

The news that Broken Hill has shut down its mills on account of a water scarcity is believed true, and has no doubt had a bullish effect on London prices. The supply of Australian lead will not be affected for some time, however. At present levels, it is again possible to sell foreign ore lead abroad, and at least two sellers have booked orders on the Continent during the week. This is the first time foreign ore lead has been sold out of the United States for months, and will, of course, decrease the supply available for domestic consumption.

The decline in lead prices has certainly been arrested for the time being, but predictions for the next month or two are difficult to make.

Daily Prices of Metals

Mar.	Copper N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N.Y.	St. L.	St. L.
11	13.90	64.125	65.125	8.275@8.40	8.00@8.20	7.30
12	13.875	64.00	65.00	8.20@8.375	8.00	7.275
13	13.90	64.00	65.00	8.20	8.00	7.30
15	13.90	64.00	65.00	8.20	8.00	7.325
16	13.90	64.875	66.00	8.20	8.00	7.35@7.40
17	13.925	64.75	66.00	8.225	8.00	7.425@7.475
Av.	13.900	64.292	65.354	8.242	8.017	7.338

*The prices correspond to the following quotations for copper delivered: March 11th 14.15c.; 12th 14.125c.; 13th, 15th and 16th 14.15c.; 17th 14.175c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Mar.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
11	58 7/8	59 1/8	65 3/4	295 1/4	286 1/2	31 7/16	31 11/16	34 5/16	34 3/8
12	58 3/4	59 1/4	65 3/4	295 3/4	287 1/4	31 9/16	31 15/16	33 7/8	34 3/16
15	59	60	65 3/4	295 1/4	287 1/4	31 13/16	32 3/16	33 3/4	34
16	59 1/2	60	66	297 3/8	288 3/4	31 15/16	32 7/16	33 3/4	34 1/8
17	59 1/4	60 1/4	66 1/4	299	289 3/8	32 3/8	32 5/8	33 7/8	34 1/4

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold London	Mar.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
11	4.85 5/8	66 1/8	30 7/16	84s11d	15	4.85 5/8	65 7/8	30 1/4	84s11d
12	4.85 5/8	66	30 5/16	84s11d	16	4.85 5/8	65 7/8	30 1/4	84s11d
13	4.85 5/8	65 7/8	30 5/16	.....	17	4.85 5/8	66	30 5/16	84s11 1/2d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths cent premium.

Zinc Prices Improve

With producers not pressing zinc on the market, prices have strengthened during the last week. Brass melters and galvanizers both are in the market, and a moderate business has been done. The price of ore in Joplin remains at $48 per ton, but the expected curtailment of production has not materialized to any great extent as yet. High-grade zinc is quoted at from 9c. to 9.25c. in New York, with fair business. The premium on Brass Special is from 10 to 12½ points.

Better Demand for Tin

The tin market has snapped out of its lethargy of recent weeks, even though there were no price declines to stimulate trade. Many consumers who have held off for some time have come into the market in the week ending today and have contracted for tin for all deliveries on a comparatively liberal scale. Prices held steady around 65c. until yesterday, when the excellent buying caused them to advance to 66c., and sales today have been made even above that, or at the highest level since August, 1919. June tin has sold at discounts of 1¼@1½c. from the prices for prompt. Spot tin is virtually unobtainable.

Silver Heavy

During the last week silver prices first sagged and then recovered, the fluctuations being entirely the result of China's position. Indian bazaars show no real interest as yet, and the market closes quiet without tendency.

Mexican Dollars: March 11th, 50⅞c.; 12th, 50⅜c.; 13th, 15th, and 16th, 50⅝c.; 17th, 50⅜c.

Francs Decline Slightly

Foreign exchanges have shown little variation from the quotations of a week ago, though francs are somewhat lower. Closing cable quotations on Tuesday, March 16, were as follows: francs, 3.60¼c.; lire, 4.02c.; and marks, 23.81c. Canadian dollars, ⅜ per cent discount.

Lead Ore Lower—Zinc Unchanged

Joplin, Mo., March 13, 1926

Zinc Blende	Per Ton
High	$56.25
Premium blende, basis 60 per cent zinc	$49.00@$50.00
Prime Western, basis 60 per cent zinc	$48.00
Fines and slimes, 60 per cent zinc	$47.00@$45.00
Average settling price, all zinc	$49.45
Galena	
High	$115.20
Basis 80 per cent lead	$110.00
Average settling price, all lead	$111.62

Shipments for the week: Blende, 13,463; calamine, 36; lead, 3,451 tons. Value, all ores the week, $1,110,980.

Buyers cut the price of zinc last week, and sellers marketed only 7,400 tons. No further reduction was offered this week. There is widespread talk of restricting the output, and this week's production shows more than 1,200 tons reduction. Despite an apparent intention expressed early today that sellers would decline current price offerings, 15,640 tons were marketed.

The cut in price of lead to $100 basis was more than was expected, and the demand was light. Restriction of zinc production is also affecting lead production.

Platteville, Wis., March 13, 1926

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$51.50
Lead Ore	
Lead, basis 80 per cent lead	$105.00

Shipments for the week: Blende, 1,174 tons; lead, 142 tons. Shipments for the year: Blende, 10,004; lead, 362 tons. Shipments for the week to separating plants, 1,924 tons blende.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

Aluminum—99 per cent grade, 28c. per lb.; 98 per cent, 27c. London, 98 per cent, £118 per long ton.

Antimony—Per pound, duty paid, New York: Chinese brands, spot, 19½@18½c. April arrival, 18½@18c. Cookson's "C" grade, spot, 23c. Market quiet and prices mostly nominal.

Bismuth—$2.70@$2.75 per lb., in ton lots. London, 10s.

Cadmium—60c. per lb. Market slow. London, 1s. 9d. for Australian metal.

Iridium — $250@$275 per oz. for 98@99 per cent. Nominal. London, £70@£75 for 99.5 per cent.

Nickel—Ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent); London, £170@£175 per long ton.

Osmium—$90@$95 per ounce; London, £23½@£25½.

Platinum — $112 per ounce refined officially quoted. Sales also at $106@$109. Crude, $105@$107. London, £22½@£23½ for refined; crude, £21@£22.

Quicksilver—Per 75-lb. flask: $88@$89 for spot and forward. San Francisco, $89. London, £15.

Ruthenium — $75@$85 per ounce; London, £16½@£19½.

The prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Palladium, Radium, Rhodium, Selenium, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of March 6.

Metallic Ores

Tungsten Ore—Per unit of WO_3, N.Y.: Wolframite, $12@$12.50; Western scheelite, $12.50@$13. Domestic demand very light, and prices largely nominal. European demand fair.

Vanadium Ore—Containing 4 to 8 per cent V_2O_5, 25@30c. per pound of V_2O_5 f.o.b. Montrose, Colo.

Chrome Ore, Iron Ore, Manganese Ore, Molybdenum, Tantalum, and Ores are unchanged from quotations in the March 6 issue.

Non-Metallic Minerals

Amblygonite, Andalusite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Ilmenite, Iron Oxide, Lepidolite, Limestone, Magnesite, Manjak, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Rutile, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the March 6 issue.

Mineral Products

Arsenious Oxide (White arsenic)—3c. per lb. Small sales. London, £14@£15 per long ton.

Copper Sulphate, Sodium Nitrate, Sodium Sulphate, and Zinc Oxide are unchanged from prices in the March 6 issue.

Ferro-Alloys

Ferrocerium, Ferrochrome, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and Ferrovanadium are unchanged from prices in the March 6 issue.

Ferromanganese—Domestic and foreign, 78@82 per cent, $100 per gross ton.

Metal Products

Rolled Copper—Sheets, 22¾c.; wire, base price, 16¼c. per lb.

Lead Sheets—Full, 12¼c. per lb.; cut, 12½c.

Nickel Silver—29¾c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal — Dimension sheets, 20¼c. per lb.; rods, 17¼c.

Zinc Sheets — 11.75c. per lb., f.o.b. works.

Refractories

Chrome Brick, Firebrick, Magnesite Brick, Silica Brick, and Zirkite are unchanged from prices in the March 6 issue.

Steel, Pig Iron, and Coke Prices Are Steady

Pittsburgh, March 16, 1926

After four months of steady operation at a record high rate for a period of such length, the steel industry shows no definite trend in production in either direction. The failure of the Wall Street slump of a fortnight ago to disturb steel buying fits the views lately held, that buying has not been anticipatory but to supply actual current wants.

All steel-consuming industries are running either well or very well. Buying of oil-country tubular goods is not increasing this month as it was in January and February, but easily holds its own. Freight-car buying and letting of fabricated structural steel jobs in the last few weeks have been fully up to their pace of late in the old year.

Pig Iron—Inquiry for second quarter is slow in developing, partly because some first-quarter contract tonnage will be carried over. Prices remain steady at $21 for bessemer, $20 for basic, and $20.50 for foundry, f.o.b. Valley furnaces.

Connellsville Coke—There is practically no buying by furnaces, but a good run of buying by miscellaneous consumers is to be recorded. Prices are steady on standard grades at $3.25 @$3.50 for furnace and $4.50@$5 for foundry.

Cost of 55 Per Cent of U. S. Copper Under 12c. Per Pound

Bureau of Metal Statistics Classifies Production With Respect to Costs—Depreciation Included but Not Depletion

Walter Renton Ingalls, Director of the American Bureau of Metal Statistics, has calculated the cost of producing copper in the United States, finding that of the total about 55 per cent costs less than 12c. per pound. He says that the cost of producing copper by any producer is not a matter of easy determination. In every instance there are complexities of accounting, administration, and economics. Consequently, it is possible to figure costs in a variety of ways, and no one of them may be true, though every one may be sincere.

In his study of this subject Mr. Ingalls has made a comparison of the cost of production by each producer by three different methods, based on net profit realized during the period of three years, 1922-24. In working out costs by these methods incomes from investments have been separated. Gold and silver have been reckoned as costing their full realization; i.e., copper has been given the benefit of full gold and silver credits. In every case, says Mr. Ingalls, depreciation is reckoned as an operating cost, for the use of plant, which is gradually worn out, is as truly an operating cost as is that of the coal and labor that are put in to run it. In no case, however, is any allowance made for depletion of ore reserves, which plays no immediate part in determining the market price for the product, although it is of course an economic cost. One company may make a deduction for depletion and use the reserve for acquiring new mines and so continuing the business; whereas another company may make no such deduction, distributing to the stockholders everything in excess of direct cost, and leaving it to the stockholders to figure their own amortization.

Extent of Development Is Factor in Cost

Costs of production are greatly affected by the extent to which a company may overdevelop or underdevelop its orebodies, incurring an excess of deferred charges or failing to keep them up to the point where they ought to be. Considering the cost of production over three successive years, however, tends to iron out this irregularity.

Estimated Cost of Copper Production, Including Depreciation and Excluding Depletion, 1922 to 1924

Cost, Cents	Total Pounds	Per Cent of Total	Average, Cents
Under 12	2,235,313,604	55.166	10.19
From 12 to 13	926,228,785	22.859	12.44
From 13 to 14	338,760,952	3.360	13.18
From 14 to 15	220,834,230	5.450	14.37
Over 16	61,213,769	1.511	16.18
Identified but unfigured	91,736,618	2.264	.....
Remainder, unfigured	177,900,042	4.390	.....
Totals	4,051,988,000	100.000	.....

In the accompanying table the copper entered as "identified but unfigured" represents the production of small companies that could be tabulated, but in respect of which costs could not be figured. The final entry of "remainder, unfigured" is represented mainly by miscellaneous, or custom, ores; i.e., those which go to customs smelters in relatively small parcels. Most of this unfigured copper, amounting to about 6.6 per cent of the total, is probably high-cost copper.

United States, Chile and Peru Account for Two-thirds of Output

The three big producers of South America during this same period made 1,169,760,068 lb. of copper at a cost of less than 10c. per pound.

Production of the mines of the United States, plus that of the three big South American producers, during these three years, accounted for about two-thirds of the world's total production of copper.

The figures given above represent bare costs and include nothing for interest on and amortization of the immense capital that is involved in copper production. It is in fact the huge initial outlays for plant that permit most of the low-cost copper to be produced at the figures that are realized in respect of direct operation. Little of the low-cost copper of North America is ascribable to high-grade ore, concludes Mr. Ingalls.

Company Reports

Hecla Lead Production Biggest in History

According to the annual report of James F. McCarthy, president and general manager of the Hecla Mining Co., mining lead and silver in Idaho, the year just closed has been characterized by full production and by good prices for the metals produced. Work was continued throughout the year on the Star property, owned equally by Bunker Hill & Sullivan and Hecla companies. This development has been very satisfactory. The whole length of this orebody has been drifted and connections have been made with the openings of the Morning mine of the Federal Mining & Smelting Co. At present about 275 tons is being produced daily, all of it from drifts and raises. This ore is sent for concentration to Kellogg.

During the year a tailings mill was constructed for the finer grinding of coarse tailings and the treatment of the ground material by flotation. This plant was placed in operation in December, will increase the recovery of minerals and, consequently, make some addition to profits. Ore reserves are estimated at 1,506,937 tons. This takes no account of the development below the 2,000 level.

Income and Expenditures for Year Ended Dec. 31, 1925

Income		
Ore sales—net receipts	$4,496,941.76	
Interest	24,828.50	
Rents	14,892.52	
Miscellaneous	14,986.64	
		$4,551,649.42
Expenditures		
Mining and development	$1,075,809.99	
Crushing, conveying and ore sorting	53,863.11	
Ore haulage—mine to mill	33,968.22	
Milling	145,578.88	
Miscellaneous (general expense, insurance, property taxes)	247,711.75	1,556,931.95
Operating income		$2,994,717.47
Depreciation reserves	$217,302.62	
Depletion of property investment	12,444.00	229,746.62
		$2,764,970.85
Dividends	$2,000,000.00	
Taxes—federal income and state net profit and miscellaneous adjusting entries	270,290.77	2,270,290.77
Addition to surplus		$494,680.08
Surplus, Dec. 31, 1924		2,827,717.64
Surplus, Dec 31, 1925		$3,322,397.72

Costs

			Per Ton Treated
Mining		$952,924.65	$2.849
Development		122,885.34	.367
Crushing, conveying and ore sorting		53,863.11	.161
Miscellaneous (general expense, insurance, property taxes)		247,711.75	.741
		$1,377,384.85	$4.118
			Per Ton Milled
Milling	$145,578.88		$0.536
Ore haulage	33,968.22		.125
		$179,547.10	$0.661
Total operating expense		$1,556,931.95	$0.661
			Per Ton Treated
Gross operating receipts		$4,551,649.42	$13.610
Gross operating expense		1,556,931.95	4.655
Net operating profit		$2,994,717.47	8.955

Production

	Dry Tons	Value	Per Ton
Concentrates	37,688.80	$2,977,579.06	$79.004
Crude ore	18,261.94	1,454,731.26	79.659
Leasers'	2,496.49	64,631.44	25.889
	$58,447.23	$4,496,941.76	$76.940
Cost of production		$1,556,931.95	26.638
Silver produced, oz		1,531,793	
Lead produced, lb		54,775,180	

The report shows that 7.2 tons of milling ore produce one ton of concentrate, and that 5.72 tons of material treated produce one ton of shipping product.

Engels Copper Co.'s Operating Profit $559,165 in 1925

The Engels Copper Co., operating in California, produced 15,187,027 lb. of copper, 192,697 oz. of silver, and 1,466 oz. of gold in 1925. The company's net operating surplus, including sundry income, was $559,165.87, which was reduced to $336,014.34 by deducting $115,831.95 for development expense written off; $106,765.18 as reserve for depletion, and $554.40 as reserve for income tax on bond interest. Dividends paid in 1925 were $371,470.43, and balance, after adjustment for surplus, was $127,655.13 on Dec. 31, 1925. Assets total $7,794,095.24. Total operating expense was $1,032,873.23, of which mining was $515,504.77, or $1.25 per ton, a reduction of 25c. per ton as compared to 1924; milling cost was $307,246.67, or 75c. per ton, a reduction of 10c. per ton over the milling cost of the previous year.

A. S. & R. Earnings Increase $4,003,769

Earnings in 1925 at the rate of $19.17 per share on common stock, after deducting preferred dividends, are shown by the annual report of the American Smelting & Refining Co., for 1925. This is an increase of $6.57 in earnings per share of common stock over 1924 and an increase of $10.28 per share compared with the record for 1923. Net income in 1925 available for all dividends after deduction of charges, taxes, bond interest, depreciation, and depletion was $15,190,760.28, which was an increase of $4,003,769.57 compared with the net income for 1924.

The company expended during the year, in new undertakings, enlargements, and betterments, $6,939,787.34, without additional financing; and expended a further sum of $1,953,242.05 for these purposes out of funds provided by special financing Series B bonds in 1923. Total current and miscellaneous assets made a gain during the year of $7,506,845.28, and stand at $96,063,061.90, slightly more than 4½ times total current and miscellaneous liabilities of $21,332,967.

A new reserve of $1,000,000 has been set up for mine and new business investigations. The company, which was originally organized for the smelting and refining business, has of recent years been steadily enlarging its activities, particularly in the acquisition of mines, and also, to a lesser degree, in the manufacturing of the refined metals into various forms. This policy not only has improved the earnings, but has tended to give greater stability because of the increased supply of raw material and the wider market for the resultant metals.

Income and Profit-and-Loss Surplus Account

	1925	1924
Net earnings of mines, smelting, refining and manufacturing plants	$26,762,845.19	$21,471,506.08
Other income—net	1,215,780.75	1,469,422.90
Net earnings, before deducting general and administrative expenses and corporate taxes	$27,978,625.94	$22,940,928.98
Deduct		
General and administrative expenses	$1,347,046.21	$1,328,698.98
Research and examination expenses	229,894.80	168,135.43
Corporate taxes (including estimated United States and Mexican income taxes)	2,321,746.13	1,612,368.85
Total to deduct	$3,898,687.14	$3,109,203.26
Net income from current operations, before providing for bond interest, depreciation, obsolescence and depletion, and after providing for all taxes	$24,079,938.80	$19,831,725.72
Deduct		
Interest on first mortgage bonds outstanding with public:		
Series "A" 5 per cent	$2,016,462.97	$2,043,023.36
Series "B" 6 per cent	571,778.47	575,827.23
Depreciation and obsolescence	4,200,270.49	3,905,617.08
Ore depletion	2,100,666.59	2,120,267.34
Total to deduct	$8,889,178.52	$8,644,735.01
Net income	$15,190,760.28	$11,186,990.71
Deduct		
Dividends on:		
Preferred stock	$3,500,000.00	$3,500,000.00
Common stock	3,964,870.00	3,202,395.00
Total to deduct	$7,464,870.00	$6,702,395.00
Surplus income for period	$7,725,890.28	$4,484,595.71

Summary of Consolidated Profit-and-Loss Surplus Account

Balance at beginning of year	$16,785,532.89	$17,767,785.67
Add		
Surplus income for period, after deducting dividends	7,725,890.28	4,484,595.71
Total	$24,511,423.17	$22,252,381.38
Deduct		
Appropriations and profit-and-loss adjustments		
Reserve for extraordinary obsolescence, and contingencies	$2,750,000.00	$5,000,000.00
Reserve for mine and new business investigations	1,000,000.00	
Employees' pension reserve	500,000.00	250,000.00
Metal stock reserve	750,000.00	.....
Miscellaneous profit-and-loss adjustments—net	.....	216,848.49
Total to deduct	$5,000,000.00	$5,466,848.49
Balance at end of year	$19,511,423.17	$16,785,532.89

Comparative Operating Statistics for 1925 and 1924

	1925	1924
Gold, oz.	1,667.849	1,868.407
Silver, oz.	82,223,189	92,229,349
Lead, tons	455,261	412,416
Copper, tons	502,831	522.472
Slab zinc, tons	45,246	39,450
Men employed	26,401	25,765
Charge smelted, tons	5,638,730	5,160,236
Bullion refined, tons	936,346	898,390
Coal used, tons	390,981	447,710
Coke used, tons	517,401	486,459
Fuel oil used, barrels	2,268,267	2,046,663
Gas used, thousands cubic feet	5,432,356	4,257,998
Ore mined, tons	1,656,212	1,551,259
Coal mined, tons	443,440	501,779
Coke produced, tons	323,384	206,189

Silver King Coalition Established New High Record in 1925

The Silver King Coalition Mines Co., operating at Park City, Utah, according to the report of M. J. Dailey, general manager, surpassed all former years in the number of tons of ore mined, gross receipts, and net profits to the treasury during 1925.

Owing to increased production in the last year, and to secure better operating efficiency, it became necessary to make improvements and betterments in equipment and plant, both underground and on surface. The most important improvement on surface was the construction of a new steel and concrete addition to the mill building and the installation therein of a new selective flotation unit consisting of twelve Mineral Separation cells of 250 tons' capacity for extraction of lead contents and twelve similar cells for extraction of zinc contents, together with the necessary grinding and other mill equipment. This gave the company a modern, up-to-date flotation unit that has been operating successfully since Jan. 3, 1926.

Total Metal Content of Ore

	Lead, Lb.	Silver, Oz.	Gold, Oz.	Copper, Lb.	Zinc
Crude first-class ore	32,461,590	2,077,044.47	2,418.158	1,159.173	.....
Lead concentrates	7,251,693	392,054.07	662.214	189,440	.....
Iron concentrates	1,948,214	78,832.57	294.547	53,068	.....
Zinc concentrates	57,733	13,040.73	10.485	11,996	742,362
Iron crude	73,390	14,107.11	14.140	15,438	.....
Lease ore	102,779	6,240.42	19.657	3,180	.....
Totals	41,895,399	2,581,319.37	3,419.201	1,432,295	742,362

Condensed Statement of Operations for the Year ended Dec. 31, 1925

Operating revenue from ore sales—			
Net smelter returns after deducting freight and treatment charges		$4,076,875.51	
Other income			
Interest on securities	$57,555.14		
Miscellaneous income	20,419.47	77,974.61	
Total income			$4,154,850.12
Operating expenses			
Mining and milling expense	$1,436,297.16		
Taxes (state and county)	135,691.19	$1,571,988.35	
Administrative	$51,831.96		
Federal taxes	258,786.49	310,618.45	
Depreciation			
Plant and equipment		56,436.96	
Total operating expenses			1,939,043.76
Net income for year			
Carried to surplus			$2,215,806.36

Mining Stocks—Week Ended March 13, 1926

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	46⅞	45⅜	45⅞	Ja.16,Fe.23,Q	0.75
Arcadian Consol.	Boston	*50	*35	*40		
Ariz. Com'l.	Boston	11⅛	11⅛	11⅛	Jy.21, Jy. 31 SA	0.50
Calaveras	N. Y. Curb	3⅛	2⅞	2⅞		
Calumet & Arizona	New York	59⅛	58¼	59	Mr.5,Mr.21 QX	1.50
Calumet & Hecla	Boston	14½	14	14⅜	Nov.30,De.15 Q	0.50
Cerro de Pasco	New York	64⅜	62¼	62⅝	Ja. 14, Fe. 1, Q	1.00
Chile Copper	New York	33⅞	33⅛	33⅞	Ma.3, Ma.29, Q	0.62½
Chino	New York	18	18	18	Sept., 1920	0.37½
Con. Coppermines	N. Y. Curb	2⅛	2	2		
Copper Range	Boston	17⅞	17⅞	17⅛	May, 1925	1.00
Crystal Copper	Boston Curb	*52	*40	*48		
East Butte	Boston	3¼	3¼	3¼	Dec., 1919	0.50
First National	Boston Curb	*15	*15	*15	Feb., 1919	0.15
Franklin	Boston	*50	*50	*50		
Granby Consol.	New York	20⅛	19	20	May, 1919	1.25
Greene-Cananea	New York	12⅛	11⅛	11⅛	Nov., 1920	0.50
Hancock	Boston			*80		
HoweSound.new,r.t.c.	New York	35⅛	32⅛	34⅛	Ja. 5, Ja. 15 Q	0.50
Inspiration Consl.	New York	24⅛	24	24	Mar.18, Ap.5,Q	0.50
Iron Cap	Boston Curb	3⅛	3⅛	3⅛	May, 1923	0.15
Isle Royale	Boston	11⅛	11	11⅛	No.30, De.5	1.00
Jerome Verde Dev.	N. Y. Curb	1⅛	*85	*85		
Kennecott	New York	54⅛	53⅛	53⅛	Ma.5,Ap.1 Q	1.00
Lake Copper	Boston	1⅛	*90	*90	June, 1925	0.50
Magma Copper	New York	41⅛	40⅛	40⅜	De.31, Ja.15,	0.75
Mason Valley	N. Y. Curb			2		
Mass Consolidated	Boston	*40	*40	*40	Nov., 1917	1.00
Miami Copper	New York	12⅛	11⅞	12⅛	Feb.1, Feb.15 Q	0.25
Mohawk	Boston	33⅛	32	33⅛	Jan. 30, Ma.1 Q	1.00
Mother Lode Coa.	New York	7	6⅞	6⅞	De. 11, De. 31	0.37½
Nevada Consol.	New York	165⅜	165⅛	165⅛	Mh.18, Mh.31 Q	0.25
New Cornelia	Boston	20⅜	19⅜	20⅛	Fe.5, Fe.23 Q	0.30
North Butte	Boston	3	2⅝	2⅝	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*67	*47	*52	No. 14, De. 2	0.05
Old Dominion	Boston	18	17⅛	17⅛	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†135	†130		De.21, Ja.2 Q	1.00
Quincy	Boston	21⅛	19½	21	Mar., 1920	1.00
Ray Consolidated	New York	12	11⅛	11⅞	Dec., 1920	0.25
Ray Hercules	N. Y. Curb			11⅞		
St. Mary's Min. Ld.	Boston	34⅛	33	33	May, 1925	3.00
Seneca Copper	New York	7	6⅞	6⅞		
Shannon	Boston	*60	*50	*55	Nov., 1917	0.25
Superior & Boston	Boston	*80	60	*60		
Tenn. C. & C.	New York	14	13	13⅜	Fe.27,Ma.15,Q	0.25
United Verde Ex.	N. Y. Curb	30	28⅛	29⅛	Ja.5, Fe.1, Q	0.75
Utah Copper	New York			98	Mh.18,Mh.31,Q	1.25
Utah Metal & T.	Boston	2⅛	1⅛	1⅞	Dec., 1917	0.30
Victoria	Boston	*50	*50	*50		
Walker Mining	Salt Lake	1.20	1.15	1.20		
NICKEL-COPPER						
Internat. Nickel	New York	39⅛	37⅛	37⅜	Ma.11,Ma.31,Q	0.50
Internat. Nickel, pfd.	New York	102⅛	102⅛	102⅛	Ja.25, Fe.1, Q	1.50
LEAD						
Gladstone M. M. Co.	Spokane	*37	*37	*37	Ja. 1, Ja. 10 M	0.01½
National Lead	New York	157½	154	154	Ma.12,Ma.31 Q	2.00
National Lead pfd.	New York	116	116	116	Aug.21, Se.15	1.75
St. Joseph Lead	New York	44	41⅛	41⅛	De.10,De.20 QX	1.50
ZINC						
Am. Z. L. & S.	New York	9	8⅛	8⅛	May., 1920	1.00
Am. Z. L. & S, pfd.	New York	35⅛	32⅛	35⅛	Nov., 1920	1.50
Butte C. & Z.	New York	5⅛	5⅛	5⅛	De.10, De.24	0.50
Butte & Superior	New York	14⅛	13⅛	13⅜	Ma.15, Ma.31 Q	0.50
Callahan Zn-Ld	New York	2	1⅞	2	Dec., 1920	0.50
Eagle Picher	Cincinnati	31	30⅛	31	My. 15, Jn.1	0.40
Eagle Picher, pfd.	Cincinnati			110	Ja.1, 15.31	1.50
New Jersey Zn.	N. Y. Curb			208	Fe.1u, Fe.28 Q	0.90
United Zinc	N. Y. Curb			*70		
Yellow Pine	Los Angeles	*41⅛	*37⅛	*37⅛	De.8, De.18 Q	0.04
GOLD						
Alaska Juneau	New York			1⅛		
Argonaut	Toronto	*36	*32	*33⅛		
Barry-Hollinger	Toronto	*42	*40	*41		
Carson Hill	Boston			*35		
Consol. W. Dome L.	Toronto	*23	*21	*22		
Cresson Consol. G.	N. Y. Curb	2⅛	2	2	De.31, Ja. 7	0.10
Crown Reserve	Toronto	*19	*17	*19	Jan., 1917	0.05
Dome Mines	New York	20	18⅛	19⅛	Mh.31, Ap.20, Q	0.50
Golden Center	N. Y. Curb	1⅛	1⅛	1⅛		
Golden Cycle	Colo. Springs	†1.53	†1.51⅛		No.30, Dec.10 Q	0.03
Hollinger Consol.	Toronto	18.65	18.35	18.65	Ma. 9, Ma. 25	0.08
Homestake Mining	New York	55	53⅛	55	Ma.20,Ma.25 M	0.50
Kirkland Lake	Toronto	1.15	1.05	1.08		
Lake Shore	Toronto	10.90	10.20	10.60	Ma.1,Ma.15 Q	0.10
McIntyre-Porcupine	New York	26⅛	24⅛	25⅛	Fe.1, Ma.7	0.05
Newray	Toronto	*41	*38⅛	*40		
Night Hawk Pen.	Toronto	*7	*6½	*7		
Noranda	N. Y. Curb	14⅛	13⅛	13⅜		
Portland	Colo. Springs	†*55	†*50		Oct., 1920	0.01
Rand Mines	New York			34⅛	Fe.16, Fe.26	1.52
Teck-Hughes	Toronto	3.30	3.15	3.22	Ja. 15, Fe. 1	0.05
Tom Reed	Los Angeles	*65	*50	*65	Ma.10,Ma.20	0.02
Tough-Oakes	Toronto	*63½	*49½	*61		
United Eastern	N. Y. Curb	*46	*46	*46	July, 1924	0.05
Vipond Cons.	Toronto	1.69	1.60	1.67		
Wright-Hargreaves	Toronto	8.70	8.50	8.70	Mh.15,Ap.11 QX	0.07½
Yukon-Alaska Trust	N. Y. Curb			20		
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	19⅜	19⅛	19⅛		
Con. Cortez	N. Y. Curb	*8	*7	*7		
Con. Virginia	San Francisco	*16	*10⅛	*13⅛		
Continental Mines	N. Y. Curb			*45		
Dolores Esperanza	N. Y. Curb			60	July, 1923	0.05
Premier Gold	N. Y. Curb	2⅛	2⅛	2⅛	Ma.19, Apr.3	0.08
Tonopah Belmont	N. Y. Curb	3⅛	3⅛	3⅛	Se.15, Oc.1	0.05
Tonopah Extension	N. Y. Curb	*83	*60	*83	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	6⅛	6⅛	6⅛	Se.30, Oc.21	0.07½
Unity Gold	N. Y. Curb			*20		
West End Consol.	N. Y. Curb			*25	Mar., 1923	0.05
Yukon Gold	N. Y. Curb			*45	June, 1918	0.02

Stock	Exch.	High	Low	Last		Last Div.
SILVER						
Alvarado	N. Y. Curb			1	Oct., 1920	0.50
Beaver Consol.	Toronto	*78⅛	*71⅛	*76	May. 1920	0.03
Castle-Trethewey	Toronto	1.65	1.60	1.63		
Coniagas	Toronto	4.20	4.00	4.00	May, 1924	0.12½
Keeley	Toronto	1.58	1.50	1.53	Ma.1,Ma.15 X	0.12
Kerr Lake	N. Y. Curb	1⅛	1⅛	1⅛	Ap.1, Ap.15	0.12½
La Rose	Toronto	*33	*24	*25⅛	Apr., 1922	0.10½
Lorrain Trout Lake	Toronto			1	Jy. 2, Jy. 15	0.05
McKinley-Dar.-Sav.	Toronto	*23⅛	*19⅛	*21	Oct., 1920	0.03
Mining Corp. Can.	Toronto	4.00	3.80	3.92	Ja. 16, Ja.30	0.12½
Nipissing	N. Y. Curb	6⅛	6⅛	6⅛	Mh.31, Ap.20, Q	0.15
Temiskaming	Toronto			*14	Jan., 1920	0.40
SILVER-LEAD						
Ahumada	New York	8⅛	7⅞	8⅛	Mh.8,Ap.5,Q X	0.25
Alta Merger	Salt Lake	†*3	†*1			
Bingham Mines	Boston	53	46⅛	51	Ma.20,Ma.31 Q	1.00
Cardiff M. & M.	Salt Lake			*57	De.16, No.18	0.10
Chief Consol.	Salt Lake	3.25	3.25	3.25	Fe. 1,	0.10
Emma Silver	Salt Lake	†*1⅛	†*1⅛			
Erupcion	Boston Curb	2	2	2	Mh.18, Ap.5,X	0.10
Federal M. & S.	New York	86	82	82		
Federal M. & S., pfd.	New York	81	68⅛	75⅛	No.25, De.15 Q	1.75
Hawthorne Mines	N. Y. Curb	*28	*20	*24		
Hecla Mining	N. Y. Curb	19⅛	16⅛	18	Fe.15, Ma.15 Q	0.50
Iron King Mining	Salt Lake	*39	*35	*39		
Keystone Mining	Salt Lake	*51	*49	*49	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*16⅛	*15⅛	*16		
Mammoth Mining	Salt Lake	3.00	3.00	3.00	De. 16, De. 23	0.10
Marsh Mines	Spokane	*6⅛	*6	*6	Se.15, Oc.1	0.15
Ontario Silver	New York			10		
Park Utah	Salt Lake	7.30	7.15	7.15	Mh.15, Ap.1 Q	0.15
Prince Cons.	Salt Lake	4	4	4		
Silver King Coal	Salt Lake	9.50	9.20	9.20	De.15, Ja.2, QX	0.35
Silversmith	Spokane	*46	*45	*46	De.31, Ja.10	0.02
Tamarack-Custer	Spokane	*49	*35	*49	Sept., 1924	0.25
Tintic Standard	Salt Lake	13.62½	13.50	13.50	De.16,De.23,QX	0.30
Utah-Apex	Boston	9⅞	9⅛	9⅛	Ja.1, Ja.5, Q	0.35
Western Utah Copper	N. Y. Curb			*8		
IRON						
Bethlehem Steel	New York	43½	40⅛	42⅜	July, 1924	1.25
Colorado Fuel & Iron	New York	32⅛	29	31	May, 1921	0.75
Gt. North'n Iron Ore	New York	74⅜	71	73	De. 4, De. 28,	0.75
Inland Steel	New York	40	38⅛	38⅛	Fe.15, Ma.1 Q	0.62½
Mesabi Iron	N. Y. Curb	1⅛	1⅛	1⅛		
Replogle Steel	New York	12⅛	11⅛	11⅛		
Republic I. & S.	New York	58	51	55⅛	May, 1921	1.50
Republic I. & S. pfd.	New York	95	93	95	Ma.15, Ap.1, Q	1.75
Sloss-Sheffield S. & I.	New York	121	112	116	Ma.10,Ma.20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York	103	103	103	Ma.20, Ap.1, Q	1.75
U. S. Steel	New York	127⅞	121⅞	124⅛	Fe.27, Ma.31 XQ	1.75
U. S. Steel pfd	New York	125⅜	125	125⅛	Fe. 3, Fe. 27, Q	1.75
Virginia I. C. & C.	New York	45	44	45	Jan., 1924	1.50
Virginia I.C.&C.pfd	New York			73⅛	De.15, Ja.2,	2.50
VANADIUM						
Vanadium Corp.	New York	32⅛	29⅜	32⅛	Fe.1, Fe.15, Q	0.50
ASBESTOS						
Asbestos Corp.	Montreal	93	85	90⅛	De.31, Ja.15 Q	1.50
Asbestos Corp., pfd.	Montreal	116	110⅛	115	De.31, Ja.15, Q	1.50
SULPHUR						
Freeport Texas	New York	26⅛	21⅛	25	Nov., 1919	1.00
Texas Gulf	New York	137⅞	131	132⅝	Ma.1, Ma.15,Q	2.50
DIAMONDS						
De Beers Consol.	New York			29	Ja.26, Fe.2	0.23
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	4⅞	4⅛	4⅛		
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	53⅛	51⅛	51⅜	Fe.18, Ma. 1, Q	1.00
Amer. Metal pfd.	New York			119	Fe. 19, Ma. 1, Q	1.75
Amer. Sm. & Ref.	New York	131⅞	123⅛	127⅛	Ja.15, Fe.1,	1.75
Amer. Sm.&Ref.pfd.	New York	114	113	113⅜	Fe.5,Ma .1, Q	1.75
Consol. M. & S.	N. Y. Curb	210	190	209	De.31, Ja.15	0.75
Federated Metals	N. Y. Curb	18⅛	18⅛	18⅛		
Newmont Mining	N. Y. Curb	54	53	53⅞	De.31, Ja.15,	0.60
Southwest Metals	N. Y. Curb			2		
U. S. Sm. R. & M.	New York	44⅞	43	44⅜	Ja.1, Ja.7, Q	0.87½
U.S. Sm. R.&M.pfd.	New York	49⅛	49	49	Ja.1, Ja.7, Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange and Henry Sachs: Colorado Springs, Colo.

PRICE WEEK ENDED MARCH 3, 1926

Name	High	Low	Last	Last Divd. Date	Amount
Aramayo Mines (25 frs.)	82/6	80/7½	82/6	Feb. 1926	5 p.c.†
British Platinum (£1)	6/3	5/6	5/6	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	16/9	15/10½	16/3	Feb. 1926	6 annas*
Bwana M'Kubwa (5s)	7/3	6/10½	7/1½		
Camp Bird (£1)	5/4½	4/7½	5/3		
El Oro (£1)	6/7½	6/1½	6/4½	Nov. 1924	2½ p.c.*
Esperanza (10s)	2/—	1/6	1/7½		
Frontino & Bolivia (£1)	8/6	7/7½	7/9	Jan. 1926	1½ p.c.
Mexican Corpn. (£1)	20/3	19/—	19/9		
Mexico Mines of El Oro (£1)	33/1½	30/—	32/6	Dec. 1925	12½ p.c.*
Nechi (pref. 10s)	In liquidation			1921–22	25 p.c.
Oroville Dredgng (£1)	4/—	3/9	4/—	Dec. 1923	3½ p.c.
Ouro Preto (£1)	2/6	2/—	2/—	May 1925	2½ p.c.
St. John del Rey (£1)	10/9	10/3	10/6	June 1925	6½ p.c.
San Francisco Mines (10s)	30/1½	29/3	29/4½	Jan. 1926	22½ p.c.
Santa Gertrudis (£1)	20/10½	19/6	20/—	July 1920	5 p.c.
Selukwe (2s. 6d.)	10/9	9/10½	10/7½	April 1917	6¼ p.c.
S. Amer. Copper (2s.)	5/3	4/10½	5/—	Nov. 1917	75 p.c.
Tanganyika (£1)	49/10½	43/9	46/10½	Sept. 1925	5 p.c.
Tomboy (£1)	3/1½	3/—	3/—	Jan. 1926	5 p.c.
Union Miniere du Haut-Katanga (Brussels)	6.700	6.450	6.500	July 1925	150 frs.‡

* Free of British income tax. † Swiss frs. ‡ Belgian frs.